DCR
Virginia Department of Conservation & Recreation

Date Prepared: November 18, 2015
Prepared By: K. Acree

DESIGN REPORT FOR THE CONSTRUCTION OR ALTERATION OF VIRGINIA REGULATED IMPOUNDING STRUCTURES

Note: Any executed Design Report for construction of an impounding structure must be mailed to the appropriate Regional Engineer. In addition, a completed Certificate and Permit Application Fee Form (DCR199-192) and the required fee must be mailed under separate cover to: Virginia Department of Conservation and Recreation, Division of Finance, Accounts Payable, 600 E. Main St., 24th Floor, Richmond, Virginia 23219.

Reference: Impounding Structures Regulations, 4VAC 50-20-10 et seq., including 4VAC 50-20-240, Virginia Soil and Water Conservation Board

1. **Project Information:**
   a. Proposed Construction: ____
   Proposed Alteration: CCR in surface impoundment will be removed and dam will be decommissioned
   b. Name of Impounding Structure: Possum Point Power Station Ash Pond ABC Dam
   c. Inventory Number: 00788 (Leave blank if new Construction)
   d. Name of Reservoir: Possum Point Power Station Ash Pond ABC
   e. Purpose of Reservoir: CCR Storage

2. **Impounding Structure Hazard Classification:**
   a. Hazard Potential Classification Table I Impounding Structure Regulations:
   (Check one) ☐ High ☒ Significant ☐ Low

3. **Location of Impounding Structure:**
   a. City or County: Prince William County
   b. Located 700 feet/miles upstream/downstream of Highway Number SR 633 Possum Point Road
   c. Name of river or stream: Quantico Creek
   d. Latitude: 38.544062°N Longitude: -77.285589°W

4. **Ownership:**
   a. Owner's Name: Dominion Generation
   If a corporation, name of representative: Michael Winters, P.E.
   b. Mailing Address: 5000 Dominion Boulevard, Glen. Allen, VA 23060
   c. Telephone: (Residential) 804-347-9451 (Business) 804-273-2376, cell: 804-347-9451
   d. Other means of communication: Michael.j.winters@dom.com

5. **Design Engineer:**
   a. Design Engineer and Design Firm: John Klamut P.E., GAI Consultants Inc.
   b. Design Engineer Virginia License Number: 048859
   c. Mailing Address: 4200 Triangle Lane, Export PA 15632
   d. Telephone: (Business) 724-387-2170

6. **Impounding Structure Data:**

a. Type of material: earth X concrete ______ masonry ______
Other: ______

Note: Identify datum used for elevations.
For new construction, complete the design configuration column.
For alteration, complete both the existing and design configuration columns.

	Existing Configuration	Design Configuration	
b. Top of Dam Elevation	23.0	N/A	Feet
c. Streambed Elevation at Toe (Lowest)	0.5	N/A	Feet
d. Height of Impounding Structure	22.5	N/A	Feet
e. Crest Length (Exclusive of Spillway)	1,200	N/A	Feet
f. Crest Width	10	N/A	Feet
g. Upstream Slope (Horizontal to Vertical)	2 H: 1 V	N/A H: N/A V	
h. Downstream Slope (Horizontal to Vertical)	2 H: 1 V	N/A H: N/A V	

7. Reservoir Data

	Existing Configuration	Design Configuration	
a. Maximum Capacity	110	N/A	Acre-feet
b. Maximum Pool Elevation	22.3	N/A	Feet
c. Maximum Pool Surface Area	12	N/A	Acres
d. Normal Capacity	Unknown	N/A	Acre-feet
e. Normal Pool Elevation	20	N/A	Feet
f. Normal Pool Surface Area	Unknown	N/A	Acres
g. Freeboard (to lowest crest elevation)	0.0	N/A	Feet

8. Spillway Data

	Type	Construction Material	Design Configuration	Invert Elevation	
a. Low Level Drain	Un-grated	Concrete	30-inch diameter	6	Feet
b. Principal Spillway	Riser with stoplogs	Concrete	4-ft. wide	22.3 to 8.5	Feet
c. Emergency Spillway	None				Feet

9. Watershed Data:

a. Drainage Area: 0.057 square miles
b. Type and Extent of Watershed Development: N/A, Facility Will Be Closed

c. Time of Concentration: ______ (hours)
d. Routing Procedure: ______ Routing Model used: ______
e. Spillway Design Flood used (check and state source):
______ PMF, source ______
______ ½ PMF, source ______
______ 100 Year, source ______
______ Other, source ______
f. Design inflow hydrograph: Volume: ______ acre-feet
Peak inflow: ______ cfs
Rainfall duration of design inflow hydrograph: ______ hours
g. Freeboard during passage of spillway design flood: ______ feet
h. Provide printouts for 6, 12, and 24 hour models

10. Additional Information:

Provide as attachments to the Design Report the following information. Note: For alteration permits the details of this information is to be in accordance with the scope of the proposed alteration:

a. A description of properties located in the dam break inundation zone downstream from the site of the proposed/existing impounding structure, including the location and number of structures, buildings, roads, utilities and other property that would be endangered should the impounding structure fail. N/A, Facility will be closed

b. Evidence that the local government or governments have been notified of the proposal by the owner to build or alter an impounding structure. Notification to the Prince William County Board of Supervisors will be submitted concurrently with this application.

c. Maps showing the location of the impounding structure that include the county or city in which the proposed/existing impounding structure is located, the location of roads and access to the site, and the outline of the impoundment. Existing aerial photographs or existing topographic maps may be used for this purpose. See Drawing in Appendix A of attached Closure Plan

d. A report of the geotechnical investigations(s) of the foundation soils, bedrock, or both and of the materials to be used to construct or alter the impounding structure. N/A, Facility will be closed

e. Design assumptions and analyses sufficient to indicate that the impounding structure will be stable during construction or alteration and during the life of the impounding structure under all conditions of impoundment operations, including rapid filling, flood surcharge, seismic loadings, and rapid drawdown of the impoundment. N/A, Facility will be closed

f. Evaluation of the stability of the impoundment rim area to safeguard against impoundment rim slides of such magnitude as to create waves capable of overtopping the impounding structure and evaluation of rim stability during seismic activity. N/A, Facility will be closed

g. Design assumptions and analyses sufficient to indicate the seepage in, around, through, or under the impounding structure, foundation, and abutments will be reasonably and practically controlled so that internal or external forces or results thereof will not endanger the stability and integrity of the impounding structure. The design report shall also include information on graded filter design. N/A, Facility will be closed

h. Calculations and assumptions relative to hydraulic and structural design of the spillway or spillways and energy dissipater or dissipaters. Spillway capacity shall conform to the criteria of Table 1 and 4VAC50-20-52. N/A

i. Provisions to ensure that the impounding structure and appurtenances will be protected against unacceptable deterioration or erosion due to freezing and thawing, wind, wave action, and rain, or any combination thereof. N/A

j. Other pertinent design data, assumptions, and analyses commensurate with the nature of the particular impounding structure and specific site conditions, including when required, a plan and water surface profile of the dam break inundation zone. N/A, Facility will be closed

k. A description of the techniques to be used to divert stream flow during construction so as to prevent hazard to life, health and property, including a detailed plan and procedures to maintain a stable impounding structure during storm events, a drawing showing temporary diversion devices, and a description of the potential impoundment during construction. N/A, Facility will be closed

l. A plan for project construction monitoring and quality control testing to confirm that construction materials and performance standards meet the design requirements. See Appendix C of the attached Closure Plan

m. Plans and specifications as required by 4VAC50-20-310 signed and sealed by the engineer. See Appendix A & D of the attached Closure Plan

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List of attached drawings and specifications:

Closure Plan Report

CERTIFICATION BY OWNER'S ENGINEER

I hereby certify that the information provided in this Design Report has been examined by me and found in my professional judgment to be ~~true~~ and correct.

Signed: ______________________ John R. Klamut Virginia Number: 048859
Professional Engineer's Signature Print Name

This 18th day of November , 20 15 .

Engineer's Virginia Seal: COMMONWEALTH OF VIRGINIA JOHN R. KLAMUT Lic. No. 048859 PROFESSIONAL ENGINEER

CERTIFICATION BY OWNER

I hereby certify that I have received this Design Report.

Signed: ______________________ Michael Winters, PE
Owner's Signature Print Name

This 19th Day of November , 20 15 .

Mail the executed form to the appropriate
Department of Conservation and Recreation
Division of Dam Safety and Floodplain Management
Regional Engineer

Impounding Structure Closure Plan

Dominion Generation
Possum Point Power Station Ash Pond ABC Dam
(Inventory No. 00788)
Possum Point Power Station
Coal Combustion Residual Surface Impoundment Closures Project
Prince William County, Virginia

GAI Project Number: C150132.00

November 2015

Prepared by: GAI Consultants, Inc.
Richmond Office
4198 Cox Road, Suite 114
Glen Allen, Virginia 23060-3328

Prepared for: Dominion Generation
5000 Dominion Boulevard
Glen Allen, Virginia 23060-3308

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IMPOUNDING STRUCTURE CLOSURE PLAN

for

Possum Point Power Station Ash Pond ABC Dam (Inventory No. 00788) POSSUM POINT POWER STATION

Dominion Generation
Prince William County, Virginia
November 2015

Owner's Engineer:
I hereby certify that the documents contained herein are accurate to the best of my knowledge and belief.

EALTH

JOHN R. KLAMUT
Lic. No. 048859

AL

R. Klamut, PE, CFM
GAI Consultants, Inc

Date

1.0 Introduction

This plan was prepared on behalf of Dominion Generation (Dominion) by GAI Consultants, Inc. This report supports the Possum Point Generating Station (Station) Coal Combustion Residual (CCR) Surface Impoundment Closures Project (Project). The purpose of this report is to provide a Closure Plan for decommissioning the impounding structure that forms Ash Pond ABC (herein referred to as CCR Surface Impoundments A, B, and C) (Inventory No. 00788) located at the Station.

Dominion is also proposing to close/modify Surface Impoundments D and E as part of the overall Project. Surface Impoundments A, B, C, D, and E are dams that are regulated by the Virginia Department of Conservation and Recreation (DCR). The Closure Plan Drawings for Surface Impoundments D and E are included in **Appendix A**. Separate Closure Reports have been prepared for the modification/closure of the Surface Impoundment D and E dam structures. Please refer to these reports for more information on the modification of these structures.

1.1 Regulatory Background

CCR Surface Impoundments A, B, C, D, and E are being closed as inactive CCR surface impoundments under the new Environmental Protection Agency (EPA) CCR regulations provided in 40 Code of Federal Regulations (CFR), Part 257.100, Subpart D, dated April 17, 2015 (CCR Rule). Dominion plans to close the impoundments prior to April 17, 2018.

The impoundments are currently regulated by the Virginia (VA) Department of Conservation and Recreation (DCR) Dam Safety Program and by the VA Department of Environmental Quality (VDEQ) under VA Pollutant Discharge Elimination System (VPDES) Permit No. VA0002071. Dominion is in the process of requesting a Solid Waste Permit from the VDEQ for closure activities associated with the CCR surface impoundments at the Station. Dominion is also in the process of obtaining a site plan for the Project from Prince William County (PWC), for permitting the stormwater, and erosion and sediment (E&S) control requirements for the Project.

1.2 Site Description

The Station is located near Dumfries in Prince William County, VA. The Station is accessed by Possum Point Road (Route 633) and is adjacent to the Potomac River and Quantico Creek. The CCR surface impoundments at the station were used as a component of the wastewater treatment system for the Station until 2003, when the Station stopped using coal as a fuel. There are currently five inactive CCR impoundments located at the Station: Surface Impoundments A, B, C, D, and E. The CCR impoundments cover a total area of approximately 120 acres as shown on the design plans in **Appendix A**. The CCR surface impoundment areas are described below.

- Surface Impoundments A, B, and C cover a total area of approximately 18 acres. They were constructed in 1955 and utilized until the 1960s. The dam that forms Surface Impoundments A, B, and C is considered a single structure for DCR dam permitting purposes. However, there are three distinct areas behind the dam that are referred to as Surface Impoundment A, Surface Impoundment B and Surface Impoundment C.
- Surface Impoundment D covers an area of approximately 64 acres. It was constructed in 1988 to replace a pre-existing impoundment in the same location. Surface Impoundment D was in use until 2003.
- Surface Impoundment E covers an area of approximately 38 acres. Surface Impoundment E was constructed in 1967 and was in use until 2003.

1.3 Overall Project Closure Description

Surface Impoundments A, B, C, and E will be closed through the removal of CCR in the impoundments. To accomplish this, CCR will be mechanically dredged from Surface Impoundment A, B, C, and E, and placed in Surface Impoundment D with consent of VADEQ and per the requirements of VPDES Permit No. VA0002071. Dredging of Surface Impoundment E to Surface Impoundment D began in June 2015. Dredging from Surface Impoundments A, B, and C to Surface Impoundment D began in August 2015.

Surface Impoundment D stopped receiving CCR before October 19, 2015. Surface Impoundment D will be closed in place, with a cover system over the CCR surface constructed in accordance with 40 CFR §257.100.b.1. The cover system will consist of both geosynthetic and soil layers that will be placed over the CCR surface to limit infiltration of water into the CCR.

2.0 Surface Impoundments A, B, and C Closure Plan

Surface Impoundments A, B, and C will be closed through the removal of the CCRs in the surface impoundments. To accomplish this activity, the CCRs will be excavated from Surface Impoundments A, B, and C and placed in Surface Impoundment D. Dredging in Surface Impoundments A, B, and C to impoundment D was stopped before October 19, 2015. Remaining CCR material in these surface impoundments will be removed and disposed offsite at an authorized disposal facility permitted to receive the material.

Closure activities will consist of dewatering the CCRs sufficiently to allow them to be excavated and placed in Surface Impoundment D, mechanically dredging the CCRs from Surface Impoundments A, B, and C, constructing temporary sediment basins, regrading the excavated impoundment area to drain, and establishing vegetation in the graded areas. The post closure surface will have drainage and E&S features installed to capture and control surface run-off when vegetation is being established. Following closure and final stabilization, surface water from the impoundment areas will discharge through drainage channels to Quantico Creek. These drainage channels are designed to convey the 25-year storm event.

This closure will include modifications to the existing embankment structure. Upon completion of closure activities and establishment of successful vegetation, a portion of the embankment will be removed to allow surface run-off to exit Surface Impoundments A, B, and C areas without attenuation. The dam for the Surface Impoundments A, B, and C will be decommissioned by partial removal of the embankment.

2.1 Closure Activities

2.1.1 Closure Plan Time-Frames

Closure is scheduled to be completed prior to April 17, 2018.

2.1.2 Closure Performance Standard

The CCR removal will be completed in accordance with the relevant provisions of the CCR Rule for closure of inactive impoundments (40 CFR §257.100.b.1.) and VDEQ closure requirements. Construction will be in accordance with the Construction Quality Control Plan and Surface Impoundment Closure Specifications located in **Appendices C** and **D**, respectively.

Stormwater Quality, Quantity and E&S control design is in accordance with *Prince William County Design and Construction Standards Manual* and utilizes E&S control measures provided in the *Virginia Erosion and Sediment Control Handbook*.

2.1.3 CCR Removal and Disposal

CCR, which were historically placed at Surface Impoundments A, B, and C, will be removed as part of the closure activities. These residuals will be transported to Surface Impoundment D and deposited there.

2.1.4 Closure Sequence

The general process for decommissioning the dam is explained below and is shown on the Surface Impoundment Closure Drawings in **Appendix A**. Phasing Drawings are provided in **Appendix A** for each closure phase and described below.

- Phase 1 - Excavation of CCRs. The CCR Removal Process consists of:
    - Dewater Surface Impoundments A, B, and C:
        a. removal of free water; and
        b. dewatering the CCRs.
    - CCRs will be mechanically dredged from Surface Impoundments A, B, and C, and will be hauled and placed within the limits of Surface Impoundment D.
    - Grade the area within Surface Impoundments A, B, and C to allow positive drainage.
- Phase 2 - Install E&S Controls and convert the dam embankment to temporary sediment ponds.
    - Import soil as needed from an on-site borrow source to provide a vegetative cover.
    - Install surface drainage controls.
    - Complete grading to establish a temporary sediment basin and install temporary outlet structures.
    - Permanent seed and mulch the disturbed area.
    - Dam Removal Description. The decommissioning process will occur during Phase 2 and consists of removing a portion of the embankment. The top of the embankment will be lowered to an elevation of 19 feet resulting in an impoundment capacity of approximately 43.5 acre-feet. At this elevation and storage, the height of the embankment will be below 25 feet, and the impoundment capacity will be below 50 acre-feet. As such, the embankment will no longer be classified as a regulatory dam under DCR regulations (4VAC50-20-30).
- Phase 3 - Temporary Sediment Basin Removal Description:
    - Once adequate vegetation is established within the limits of the closure area, water will be pumped from the temporary E&S control basin.
    - The portion of the embankment which forms the temporary sediment basin will be removed, fill will be added within the limits of the removed temporary E&S control basin, and the area will be graded to drain.

- Drainage channels B-1, B-2, B-3, C-1, and C-2 will be extended.
- The disturbed area will be seeded and mulched.

2.1.5 Maintenance Needs

The cover system is designed to function effectively with minimum maintenance needs. The top surface will be graded to provide positive drainage and to prevent ponding. The vegetative cover specified will be monitored closely, particularly in the establishment year and will be reseeded and mulched as necessary. After vegetation is established and the temporary sediment basin is removed, the Surface Impoundments A, B, and C overland areas will be allowed to turn to a natural state and will not require maintenance. Dominion will perform maintenance on drainage channels and culverts in the Surface Impoundments A, B, and C areas as necessary to prevent major erosion.

2.1.6 Schedule for Closure

This application anticipates closure will be completed prior to April 17, 2018.

2.1.7 Posting

Signs will be posted at the locking gates of the facility's access points. These signs will indicate that the site is closed and unauthorized entrance is prohibited.

2.1.8 Notification

The Project will comply with the Site Plan requirements of Prince William County, VA. Notification to the Prince William County Board of Supervisors will be made with the alteration permit application submittal, after review by DCR.

2.1.9 Certification

The required certification by a registered professional engineer will be provided at the appropriate time following completion of closure activities. A record report will be provided to the DCR to document the completion of the construction activities and decommissioning of the dam structure.

2.2 Closure Calculations

Appendix B contains calculations for peak storm run-off and volumes, and surface water management facilities (drainage channels, etc.). The calculations demonstrate the design of the proposed breach will pass the anticipated drainage flows and the dam embankment will no longer impound water or be a jurisdictional structure.

2.3 Surface Impoundment Closure Specifications and Construction Quality Control Plan

Construction of the proposed plan will be completed in general accordance with the Construction Specifications and Construction Quality Control Plan. The Construction Quality Control Plan and Specifications are included in **Appendices C** and **D**, respectively.

2.4 Post-Closure Activities

There are no post closure care requirements following the dam decommissioning. The stormwater and E&S monitoring will be completed in accordance with Prince William County land disturbance requirements. The following post-closure information is provided for additional information.

2.4.1 Post-Closure Contact

Dominion Generation
5000 Dominion Boulevard
Glen Allen, Virginia 23060-3308
Contact Name: Michael Winters, P.E.
Telephone: 804-273-2376

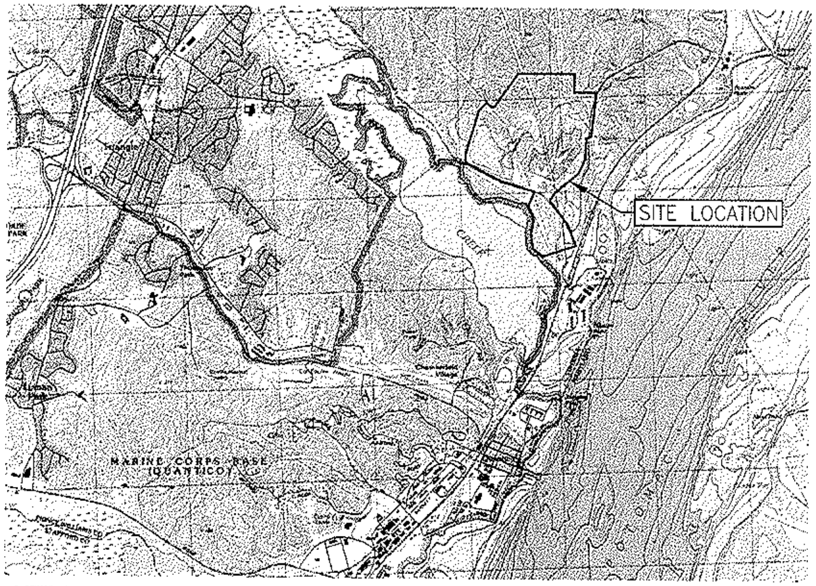
2.4.2 Security

Access to the closed facility will be controlled by gates secured with lock and key. Vehicle access adjacent to the gates will be denied by physical barriers (natural tree line, surface water channels/streams, or post barricades).

2.4.3 Post-Closure Uses

There are no current plans to develop the site, which will remain closed to the general public. The site will be vegetated to create an herbaceous habitat.

APPENDIX A
Closure Drawings



MAP REFERENCE:
USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLES:
QUANTICO, VIRGINIA-MARYLAND, 1994

VICINITY MAP
1" = 2000'

SCALE: 1" = 2000'
2000 0 2000 4000

COAL COMBUSTION RESIDUAL SURFACE IMPOUNDMENT CLOSURES

POSSUM POINT POWER STATION

PRINCE WILLIAM COUNTY, VIRGINIA

PREPARED FOR:

DOMINION

5000 DOMINION BOULEVARD
GLEN ALLEN, VIRGINIA 23060

PREPARED BY:

GAI CONSULTANTS, INC.

4198 COX ROAD, SUITE 114,
GLEN ALLEN, VIRGINIA 23060

VIRGINIA DEPARTMENT OF CONSERVATION & RECREATION DAM MODIFICATION PERMIT DRAWINGS

NOVEMBER 18, 2015

NOT FOR CONSTRUCTION

DRAWING INDEX

GAI DRAWING FILE NUMBER	SHEET NUMBER	DRAWING TITLE
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C150132-00-000-C-D1-050	51 OF 65	DETAILS – CAP SYSTEM (2 OF 2)
C150132-00-000-C-D1-052	52 OF 65	DETAILS – STORMWATER (1 OF 2)
C150132-00-000-C-D1-053	53 OF 65	DETAILS – STORMWATER (2 OF 2)
C150132-00-000-C-D1-054	54 OF 65	DETAILS – MISCELLANEOUS (1 OF 3)
C150132-00-000-C-D1-055	55 OF 65	DETAILS – MISCELLANEOUS (2 OF 3)
C150132-00-000-C-D1-056	56 OF 65	DETAILS – MISCELLANEOUS (3 OF 3)
C150132-00-000-C-D1-057	57 OF 65	DETAILS – EROSION AND SEDIMENT CONTROL
C150132-00-000-C-D1-058	58 OF 65	DRAINAGE AREA MAP – PREDEVELOPMENT (1 OF 2)
C150132-00-000-C-D1-058	59 OF 65	DRAINAGE AREA MAP – PREDEVELOPMENT (2 OF 2)
C150132-00-000-C-D1-060	60 OF 65	DRAINAGE AREA MAP – POST-DEVELOPMENT (1 OF 2)
C150132-00-000-C-D1-060	61 OF 65	DRAINAGE AREA MAP – POST-DEVELOPMENT (2 OF 2)
C150132-00-000-C-D1-062	62 OF 65	RESOURCE PROTECTION AREAS METES AND BOUNDS (1 OF 2)
C150132-00-000-C-D1-062	63 OF 65	RESOURCE PROTECTION AREAS METES AND BOUNDS (2 OF 2)
C150132-00-000-C-D1-064	64 OF 65	UNIT PRICE LISTS (1 OF 2)
C150132-00-000-C-D1-064	65 OF 65	UNIT PRICE LISTS (2 OF 2)

DRAWING TITLE: TITLE SHEET

PROJECT: POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA

gai consultants

CLIENT: VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA

ISSUING OFFICE: Richmond | 4198 Cox Road, Suite 114, Glen Allen, VA 23060

NO.	DATE	DWN	CHK	APV	DESCRIPTION

REVISION RECORD

JOHN R. KLAMUT
11/18/2015

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SHEET NO.: 1 OF 65
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PERMIT

GENERAL EROSION AND SEDIMENT CONTROL NOTES

1. THE OWNER/DEVELOPER MUST NOTIFY THE DEPARTMENT OF PUBLIC WORKS AT (434) 792-7070 AT LEAST 24 HOURS PRIOR TO THE START OF CONSTRUCTION IN ACCORDANCE WITH APPLICABLE COUNTY ORDINANCES AND POLICIES.

2. THE OWNER/DEVELOPER GRANTS THE RIGHT-OF-ENTRY ONTO THIS PROPERTY TO THE DESIGNATED PRINCE WILLIAM COUNTY PERSONNEL FOR THE PURPOSE OF INSPECTING AND MONITORING FOR COMPLIANCE WITH TITLE 10.1, CHAPTER 5, ARTICLE 4 OF THE CODE OF VIRGINIA EROSION AND SEDIMENT CONTROL LAW AND THE DESIGN AND CONSTRUCTION STANDARDS MANUAL SECTION 750.04.2.

3. ALL EROSION CONTROL MEASURES SHOWN ON THE APPROVED PLAN MUST BE IN PLACE AND INSPECTED AND APPROVED BY THE DEPARTMENT OF PUBLIC WORKS PRIOR TO CLEARING AND STRIPPING OF TOPSOIL OR GRADING.

4. A COPY OF THE APPROVED EROSION AND SEDIMENT CONTROL PLAN SHALL BE MAINTAINED ON THE SITE AT ALL TIMES.

5. THE CONTRACTOR IS RESPONSIBLE FOR INSTALLATION OF ANY ADDITIONAL EROSION CONTROL MEASURES NECESSARY TO PREVENT EROSION AND SEDIMENTATION, AS DETERMINED BY PRINCE WILLIAM COUNTY.

6. ALL DISTURBED AREAS ARE TO DRAIN TO APPROVED SEDIMENT CONTROL MEASURES AT ALL TIMES DURING LAND DISTURBANCE ACTIVITIES AND DURING SITE DEVELOPMENT UNTIL COMPLETE AND ADEQUATE STABILIZATION IS ACHIEVED.

7. DURING DEWATERING OPERATIONS, WATER WILL BE PUMPED INTO AN APPROVED FILTERING OR WATER TREATMENT DEVICE.

8. ALL EROSION AND SEDIMENT CONTROL PRACTICES MUST BE CONSTRUCTED AND MAINTAINED IN ACCORDANCE WITH THE MINIMUM STANDARDS AND SPECIFICATIONS OF THE VIRGINIA EROSION AND SEDIMENT CONTROL HANDBOOK AND THE VIRGINIA REGULATIONS VR 625-02-00 EROSION AND SEDIMENT CONTROL REGULATIONS AND TO THE PRINCE WILLIAM COUNTY DESIGN AND CONSTRUCTION STANDARDS MANUAL.

9. THE CONTRACTOR WILL BE RESPONSIBLE FOR THE INSTALLATION AND MAINTENANCE OF ALL EROSION AND SEDIMENT CONTROL PRACTICES AT ALL TIMES.

10. THE CONTRACTOR SHALL INSPECT ALL EROSION AND SEDIMENT CONTROL MEASURES AT LEAST ONCE EVERY 2 WEEKS AND WITHIN 48 HOURS FOLLOWING ANY RUNOFF PRODUCING STORM EVENT. THE FOLLOWING ITEMS WILL BE CHECKED IN PARTICULAR:

   a. SEDIMENT BASINS WILL BE CLEANED OUT WHEN THE LEVEL OF SEDIMENT BUILDUP REACHES THE CLEANOUT ELEVATION INDICATED IN THE DETAILS OF THE PLAN DRAWINGS. SEDIMENT SHALL BE DISPOSED OF IN SUITABLE AREAS AND IN SUCH A MANNER THAT IT WILL NOT ERODE OR CAUSE SEDIMENTATION PROBLEMS.

   b. THE BASIN EMBANKMENTS WILL BE CHECKED REGULARLY TO ENSURE THAT THEY ARE STRUCTURALLY SOUND AND HAVE NOT BEEN DAMAGED BY EROSION OR CONSTRUCTION EQUIPMENT.

   c. EMERGENCY SPILLWAYS WILL BE CHECKED REGULARLY TO ENSURE THAT THE LININGS ARE WELL ESTABLISHED AND EROSION RESISTANT.

   d. SEDIMENT TRAPS WILL BE CHECKED REGULARLY FOR SEDIMENT CLEANOUT. SEDIMENT SHALL BE REMOVED AND THE TRAP RESTORED TO ITS ORIGINAL DIMENSIONS WHEN THE SEDIMENT HAS ACCUMULATED TO ONE HALF THE DESIGN VOLUME OF THE WET STORAGE. SEDIMENT REMOVED FROM THE TRAP SHALL BE DISPOSED OF IN A SUITABLE AREA AND IN SUCH A MANNER THAT IT DOES NOT ERODE OR CAUSE SEDIMENTATION PROBLEMS.

   e. RIPRAP PROTECTION WILL BE CHECKED REGULARLY FOR SEDIMENT BUILDUP WHICH WILL PREVENT DRAINAGE AND SCOUR. RUNOFF THAT IS SEDIMENT-LADEN MUST BE CONSIDERED WHEN CONSTRUCTION TAKES PLACE.

   f. SILT FENCE BARRIERS WILL BE CHECKED REGULARLY FOR UNDERMINING OR DETERIORATION OF THE FABRIC AND IMMEDIATELY AFTER EACH RUNOFF PRODUCING RAINFALL EVENT AND AT LEAST DAILY DURING PROLONGED RAINFALL. SEDIMENT SHALL BE REMOVED WHEN THE LEVEL OF SEDIMENT DEPOSITION REACHES HALF THE HEIGHT OF THE BARRIER.

   g. SEEDED AREAS WILL BE CHECKED REGULARLY TO ENSURE THAT A GOOD STAND OF VEGETATION IS MAINTAINED. AREAS WILL BE FERTILIZED AND RESEEDED AS NEEDED.

   h. STREAM DIVERSIONS AND STORM CONVEYANCE CHANNELS SHALL BE INSPECTED REGULARLY AND WITHIN 48 HOURS FOLLOWING A RUNOFF PRODUCING RAIN EVENT TO ENSURE THEY ARE FUNCTIONING PROPERLY AND THAT THE INTEGRITY OF THE LININGS ARE NOT IMPAIRED.

11. ANY NECESSARY REPAIRS OR CLEANUP TO MAINTAIN THE EFFECTIVENESS OF THE EROSION CONTROL DEVICES MUST BE MADE IMMEDIATELY AFTER THE INSPECTION.

12. SEDIMENT BASINS, SEDIMENT TRAPS, PERIMETER DIKES, SEDIMENT BARRIERS, AND OTHER MEASURES INTENDED TO TRAP SEDIMENT, IF NEEDED, SHALL BE CONSTRUCTED AS A FIRST STEP IN ANY LAND-DISTURBING ACTIVITY AND SHALL BE MADE FUNCTIONAL BY SEEDING AND MULCHING IMMEDIATELY FOLLOWING INSTALLATION.

13. SEDIMENT TRAPS AND BASINS SHALL BE DESIGNED AND CONSTRUCTED BASED UPON THE TOTAL DRAINAGE AREA TO BE SERVED BY THE TRAP OR BASIN AS FOLLOWS:

SEDIMENT TRAPS
- ONLY CONTROL DRAINAGE AREAS LESS THAN 3 ACRES
- MINIMUM STORAGE CAPACITY OF 134 CUBIC YARDS PER ACRE OF DRAINAGE AREA

SEDIMENT BASINS
- CONTROL DRAINAGE AREAS GREATER THAN OR EQUAL TO 3 ACRES
- MINIMUM STORAGE CAPACITY OF 134 CUBIC YARDS PER ACRE OF DRAINAGE AREA
- THE OUTFALL SYSTEM SHALL, AT A MINIMUM, MAINTAIN THE STRUCTURAL INTEGRITY OF THE BASIN DURING A 25-YEAR STORM OF 24-HOUR DURATION

14. SOIL STABILIZATION
   a. PERMANENT OR TEMPORARY SOIL STABILIZATION SHALL BE APPLIED TO DENUDED AREAS WITHIN SEVEN (7) DAYS AFTER FINAL GRADE IS REACHED ON ANY PORTION OF THE SITE.
   b. TEMPORARY SOIL STABILIZATION SHALL BE APPLIED WITHIN SEVEN (7) DAYS TO DENUDED AREAS THAT MAY NOT BE AT FINAL GRADE BUT WILL REMAIN DORMANT FOR LONGER THAN FOURTEEN (14) DAYS.
   c. PERMANENT STABILIZATION SHALL BE APPLIED TO AREAS THAT ARE TO BE LEFT DORMANT FOR MORE THAN SIX (6) MONTHS.
   d. SEEDING AND SELECTION OF THE SEED MIXTURE SHALL BE IN ACCORDANCE WITH THE VIRGINIA EROSION AND SEDIMENT CONTROL HANDBOOK STANDARD AND SPECIFICATION 3.32 AND AS INDICATED ON THESE PLANS.
   e. ROADS AND PARKING AREAS SHALL BE STABILIZED IMMEDIATELY AFTER FINAL GRADE IS REACHED.

15. ROCK CHECK DAMS SHOULD BE INSPECTED AFTER EACH RUNOFF-PRODUCING STORM EVENT AND SEDIMENT SHOULD BE REMOVED AFTER LEVELS HAVE REACHED ONE HALF THE ORIGINAL HEIGHT OF DAM.

16. ALL TEMPORARY EROSION AND SEDIMENT CONTROL MEASURES SHALL BE REMOVED WITHIN 30 DAYS AFTER FINAL SITE STABILIZATION OR AFTER THE TEMPORARY MEASURES ARE NO LONGER NEEDED, UNLESS OTHERWISE AUTHORIZED BY PRINCE WILLIAM COUNTY INSPECTORS. TRAPPED SEDIMENT AND THE DISTURBED SOIL AREAS RESULTING FROM THE DISPOSITION OF TEMPORARY MEASURES SHALL BE PERMANENTLY STABILIZED TO PREVENT FURTHER EROSION AND SEDIMENTATION.

17. DURING CONSTRUCTION, SOIL STOCKPILES AND BORROW AREAS SHALL BE STABILIZED OR PROTECTED WITH SEDIMENT TRAPPING MEASURES. TEMPORARY PROTECTION AND PERMANENT STABILIZATION SHALL BE APPLIED TO ALL SOIL STOCKPILES ON SITE AND BORROW AREAS OR SOIL INTENTIONALLY TRANSPORTED OFF SITE.

18. PERMANENT VEGETATIVE COVER SHALL BE ESTABLISHED ON DENUDED AREAS NOT OTHERWISE PERMANENTLY STABILIZED. PERMANENT VEGETATION SHALL NOT BE CONSIDERED ESTABLISHED UNTIL A GROUND COVER IS ACHIEVED THAT IS:
- UNIFORM
- MATURE ENOUGH TO SURVIVE
- WILL INHIBIT EROSION

19. STABILIZATION MEASURES SHALL BE APPLIED TO EARTHEN STRUCTURES SUCH AS DAMS, DIKES, AND DIVERSIONS IMMEDIATELY AFTER INSTALLATION.

20. CUT AND FILL SLOPES SHALL BE DESIGNED AND CONSTRUCTED IN A MANNER THAT WILL MINIMIZE EROSION. SLOPES FOUND TO BE ERODING EXCESSIVELY WITHIN ONE YEAR OF PERMANENT STABILIZATION SHALL BE PROVIDED WITH ADDITIONAL SLOPE STABILIZING MEASURES UNTIL THE PROBLEM IS CORRECTED.

21. CONCENTRATED RUNOFF SHALL NOT FLOW DOWN CUT OR FILL SLOPES UNLESS CONTAINED WITHIN AN ADEQUATE TEMPORARY OR PERMANENT CHANNEL, FLUME, OR SLOPE DRAIN STRUCTURE.

22. WHENEVER WATER SEEPS FROM A SLOPE FACE, ADEQUATE DRAINAGE OR OTHER PROTECTION SHALL BE PROVIDED.

23. ALL STORM SEWER INLETS MADE OPERABLE DURING CONSTRUCTION SHALL BE PROTECTED SO THAT SEDIMENT-LADEN WATER CANNOT ENTER THE STORMWATER CONVEYANCE SYSTEM WITHOUT FIRST BEING FILTERED OR OTHERWISE TREATED TO REMOVE SEDIMENT.

24. BEFORE NEWLY CONSTRUCTED STORMWATER CONVEYANCE CHANNELS OR PIPES ARE MADE OPERATIONAL, ADEQUATE OUTLET PROTECTION AND ANY REQUIRED TEMPORARY OR PERMANENT CHANNEL LINING SHALL BE INSTALLED IN BOTH THE CONVEYANCE CHANNEL AND THE RECEIVING CHANNEL.

25. WHEN WORK IN A LIVE WATERCOURSE IS PERFORMED:
- PRECAUTIONS SHALL BE TAKEN TO MINIMIZE ENCROACHMENT, CONTROL SEDIMENT TRANSPORT, AND STABILIZE THE WORK AREA TO THE GREATEST EXTENT POSSIBLE DURING CONSTRUCTION.
- NONERODIBLE MATERIAL SHALL BE USED FOR THE CONSTRUCTION OF THE CAUSEWAYS AND COFFERDAMS.
- EARTHEN FILL MAY BE USED FOR THESE STRUCTURES IF ARMORED BY NONERODIBLE COVER MATERIALS.

26. WHEN A LIVE WATERCOURSE MUST BE CROSSED BY CONSTRUCTION VEHICLES MORE THAN TWICE IN ANY SIX (6) MONTH PERIOD, A TEMPORARY VEHICULAR STREAM CROSSING CONSTRUCTED OF NONERODIBLE MATERIAL SHALL BE PROVIDED.

27. ALL APPLICABLE FEDERAL, STATE, AND LOCAL REGULATIONS PERTAINING TO WORKING IN OR CROSSING LIVE WATERCOURSES SHALL BE MET.

28. THE BED AND BANKS OF A WATERCOURSE SHALL BE STABILIZED IMMEDIATELY AFTER WORK IN THE WATERCOURSE IS COMPLETED.

29. UNDERGROUND UTILITY LINES SHALL BE INSTALLED IN ACCORDANCE WITH THE FOLLOWING STANDARDS IN ADDITION TO OTHER APPLICABLE CRITERIA:
- NO MORE THAN 500 LINEAR FEET OF TRENCH MAY BE OPENED AT ONE TIME.
- EXCAVATED MATERIAL SHALL BE PLACED ON THE UPHILL SIDE OF TRENCHES.
- EFFLUENT FROM DEWATERING OPERATIONS SHALL BE FILTERED OR PASSED THROUGH AN APPROVED SEDIMENT TRAPPING DEVICE, OR BOTH, AND DISCHARGED IN A MANNER THAT DOES NOT ADVERSELY AFFECT FLOWING STREAMS OR OFF-SITE PROPERTY.
- MATERIAL USED FOR BACKFILLING TRENCHES SHALL BE PROPERLY COMPACTED IN ORDER TO MINIMIZE EROSION AND PROMOTE STABILIZATION.
- RESTABILIZATION SHALL BE ACCOMPLISHED IN ACCORDANCE WITH THE EROSION AND SEDIMENTATION CONTROL REGULATIONS FOR PRINCE WILLIAM COUNTY, (SECTION 700-ENVIRONMENTAL SYSTEMS).
- EXCAVATIONS SHALL COMPLY WITH APPLICABLE SAFETY REGULATIONS.

30. STORMWATER MANAGEMENT – PROPERTIES AND WATERWAYS DOWNSTREAM FROM DEVELOPMENT SITES SHALL BE PROTECTED FROM SEDIMENT DEPOSITION, EROSION, AND DAMAGE DUE TO INCREASES IN VOLUME, VELOCITY, AND PEAK FLOW RATE, FOR THE STATED FREQUENCY STORM OF 24-HOUR DURATION, IN ACCORDANCE WITH THE FOLLOWING STANDARDS AND CRITERIA:
- CONCENTRATED STORMWATER RUNOFF LEAVING A DEVELOPMENT SITE SHALL BE DISCHARGED DIRECTLY INTO AN ADEQUATE, NATURAL OR MAN-MADE RECEIVING CHANNEL, PIPE, OR STORM SEWER SYSTEM. FOR THOSE SITES WHERE RUNOFF IS DISCHARGED INTO A PIPE OR PIPE SYSTEM, A DOWNSTREAM STABILITY ANALYSIS AT THE OUTFALL OF THE PIPE OR PIPE SYSTEM SHALL BE PERFORMED.
- ADEQUACY OF ALL CHANNELS AND PIPES SHALL BE VERIFIED:
  + NATURAL CHANNELS – USE 2-YEAR STORM EVENT
  + MANMADE CHANNELS – USE 2-, 10-, AND 25-YEAR STORM EVENT
  + PIPE AND PIPE SYSTEMS – USE 10-YEAR STORM EVENT
- IF EXISTING NATURAL RECEIVING CHANNELS OR PREVIOUSLY CONSTRUCTED MAN-MADE CHANNELS OR PIPES ARE NOT ADEQUATE, THE APPLICANT SHALL PROVIDE CHANNEL, PIPE, OR PIPE SYSTEM IMPROVEMENTS OR PROVIDE A COMBINATION OF CHANNEL IMPROVEMENTS, SITE DESIGN, STORMWATER DETENTION, OR OTHER MEASURES THAT ARE SATISFACTORY TO THE PROGRAM AUTHORITY TO PREVENT DOWNSTREAM EROSION.
- PROVIDE EVIDENCE OF PERMISSION TO MAKE IMPROVEMENTS.
- IF THE APPLICANT CHOOSES AN OPTION THAT INCLUDES STORMWATER DETENTION HE SHALL OBTAIN APPROVAL FROM THE LOCALITY OF A PLAN FOR MAINTENANCE OF THE DETENTION FACILITIES. THE PLAN SHALL SET FORTH THE MAINTENANCE REQUIREMENTS OF THE FACILITY AND THE PERSON RESPONSIBLE FOR PERFORMING THE MAINTENANCE.
- OUTFALL FROM A DETENTION FACILITY SHALL BE DISCHARGED TO A RECEIVING CHANNEL, AND ENERGY DISSIPATORS SHALL BE PLACED AT THE OUTFALL OF ALL DETENTION FACILITIES AS NECESSARY TO PROVIDE A STABILIZED TRANSITION FROM THE FACILITY TO THE RECEIVING CHANNEL.
- INCREASED VOLUMES OF SHEET FLOWS THAT MAY CAUSE EROSION OR SEDIMENTATION ON ADJACENT PROPERTIES, SHALL BE DIVERTED TO A STABLE OUTLET, ADEQUATE CHANNEL, PIPE OR PIPE SYSTEM, OR TO A DETENTION FACILITY.
- IN APPLYING THESE STORMWATER RUNOFF CRITERIA, INDIVIDUAL LOTS OR PARCELS IN A RESIDENTIAL, COMMERCIAL OR INDUSTRIAL DEVELOPMENT SHALL NOT BE CONSIDERED TO BE SEPARATE DEVELOPMENT PROJECTS. INSTEAD, THE DEVELOPMENT AS A WHOLE SHALL BE CONSIDERED TO BE A SINGLE DEVELOPMENT PROJECT.
- ALL MEASURES USED TO PROTECT PROPERTIES AND WATERWAYS SHALL BE EMPLOYED IN A MANNER THAT MINIMIZES IMPACTS ON THE PHYSICAL, CHEMICAL, AND BIOLOGICAL INTEGRITY OF RIVERS, STREAMS AND OTHER WATERS OF THE STATE.

31. UNLESS OTHERWISE INDICATED, ALL VEGETATIVE AND STRUCTURAL EROSION AND SEDIMENT CONTROL PRACTICES WILL BE CONSTRUCTED AND MAINTAINED ACCORDING TO MINIMUM STANDARDS AND SPECIFICATIONS OF THE VIRGINIA EROSION AND SEDIMENT CONTROL HANDBOOK AND VIRGINIA REGULATIONS 4VAC50-30, EROSION AND SEDIMENT CONTROL REGULATIONS.

32. THE PLAN APPROVING AUTHORITY MUST BE NOTIFIED ONE WEEK PRIOR TO THE PRE-CONSTRUCTION CONFERENCE, ONE WEEK PRIOR TO THE COMMENCEMENT OF LAND DISTURBING ACTIVITY, AND ONE WEEK PRIOR TO THE FINAL INSPECTION.

33. WHERE CONSTRUCTION VEHICLE ACCESS ROUTES INTERSECT PAVED OR PUBLIC ROADS:
- PROVISIONS SHALL BE MADE TO MINIMIZE THE TRANSPORT OF SEDIMENT BY VEHICULAR TRACKING ONTO THE PAVED SURFACE.
- WHERE SEDIMENT IS TRANSPORTED ONTO A PAVED OR PUBLIC ROAD SURFACE, THE ROAD SURFACE SHALL BE CLEANED THOROUGHLY AT THE END OF EACH DAY.
- SEDIMENT SHALL BE REMOVED FROM THE ROADS BY SHOVELING OR SWEEPING, AND TRANSPORTED TO A SEDIMENT CONTROL DISPOSAL AREA. STREET WASHING SHALL BE ALLOWED ONLY AFTER SEDIMENT IS REMOVED IN THIS MANNER.

34. AREAS WHICH ARE NOT TO BE DISTURBED WILL BE CLEARLY MARKED BY FLAGS, SIGNS, ETC.

35. RPA AND FLOOD PLAIN LIMITS SHALL BE CLEARLY MARKED IN THE FIELD BY FLAGS, SIGNS, ETC.

36. TREES SHOULD BE CLEARED AS NECESSARY WITHIN THE LIMITS OF DISTURBANCE TO COMPLETE THE WORK. THE LIMITS OF CLEARING SHOULD BE MINIMIZED TO REDUCE THE AMOUNT OF DISTURBANCE.

37. TREE SAVE AREAS SHALL BE CLEARLY MARKED IN THE FIELD BY ORANGE SAFETY FENCE. APPROPRIATE TREE PRESERVATION SIGNS (WATERPROOF) TO IDENTIFY TREE PRESERVATION AREAS SHALL BE LOCATED ON TREE PROTECTION FENCING (INCLUDES SUPER SILT FENCING) AND SHOULD ALTERNATE ENGLISH AND SPANISH EVERY 30 FEET.

38. ORANGE SAFETY FENCE MUST BE INSTALLED AROUND ALL SILT TRAPS AND SEDIMENT BASINS IMMEDIATELY AFTER THEIR FACILITIES ARE CONSTRUCTED.

EROSION CONTROL NARRATIVE:

1. PROJECT DESCRIPTION:

THE PURPOSE OF THIS PLAN IS TO SHOW THE PLANNED WORK ASSOCIATED WITH THE POND CLOSURES AT THE DOMINION POSSUM POINT POWER STATION LOCATED IN PRINCE WILLIAM COUNTY. WORK FOR THE PROPOSED CLOSURE PLAN IS ANTICIPATED TO OCCUR OVER THE NEXT THREE (3) YEARS. THE GENERAL CONSTRUCTION PLANS INCLUDE DEWATERING THE PONDS, MECHANICALLY DREDGING CCR FROM PONDS A, B, C, AND E, REGRADING THE AREA WITHIN THE PONDS, MODIFICATION OF IMPOUNDING STRUCTURES, CONSTRUCTION OF STORMWATER AND EROSION AND SEDIMENT CONTROL MEASURES, REMOVAL OF TEMPORARY SEDIMENTATION BASINS, AND POST-CLOSURE VEGETATION. THE PROPOSED WORK IS ANTICIPATED TO DISTURB UP TO 120 ACRES OF EXISTING POND AREA, AND 24.61 ACRES OF NEW AREA IN THE PROPOSED BORROWED AREAS.

2. EXISTING SITE CONDITIONS:

THE POSSUM POINT POWER STATION IS LOCATED NEAR DUMFRIES, VA AND IS ACCESSED BY POSSUM POINT ROAD (ROUTE 633) AND IS ADJACENT TO THE POTOMAC RIVER AND QUANTICO CREEK. THE STATION SLUICED CCR INTO THE CCR PONDS UNTIL 2003, WHEN THE STATION STOPPED USING COAL AS FUEL. THE CCR PONDS AT THE STATION CONSIST OF THE FOLLOWING IMPOUNDMENT AREAS: POND A, POND B, POND C, POND D, AND POND E. THE CCR PONDS COVER A TOTAL OF APPROXIMATELY 120 ACRES. DOMINION HAS REQUESTED FOR ALTERATION PERMITS FROM THE VIRGINIA DEPARTMENT OF CONSERVATION AND RECREATION (DCR) FOR THE IMPOUNDING STRUCTURES FOR EACH POND AND DISCHARGE FROM THE PONDS IS PERMITTED UNDER THE STATION'S INDUSTRIAL VIRGINIA POLLUTANT DISCHARGE ELIMINATION SYSTEM PERMIT NO. VA0002071. THE PONDS ARE DESCRIBED BELOW:

   a. PONDS A, B, AND C COVER AN AREA OF APPROXIMATELY 18 ACRES. PONDS A, B, AND C WERE CONSTRUCTED IN 1955 AND UTILIZED UNTIL THE 1960s. THE DAM THAT IMPOUNDS PONDS A, B, AND C IS CONSIDERED A SINGLE STRUCTURE. HOWEVER, THERE ARE THREE DISTINCT AREAS WITHIN THE IMPOUNDMENT THAT ARE REFERRED TO AS POND A, POND B AND POND C. AS OF AUGUST 2015, THE CCR IN PONDS A, B, AND C ARE BEING DREDGED AND PLACED IN POND D IN ACCORDANCE WITH VPDES PERMIT NO. VA0002071. DRAINAGE FROM PONDS A, B, AND C IS BEING PUMPED TO POND D FOR STORAGE BEFORE IT CAN BE DISCHARGED IN ACCORDANCE WITH VPDES PERMIT NO. VA0002071.

   b. POND D COVERS AN AREA OF APPROXIMATELY 64 ACRES. POND D WAS CONSTRUCTED IN 1988 TO REPLACE AN EXISTING CCR POND D WHICH WAS LOCATED IN THE SAME LOCATION. CCR GENERATED BY THE STATION WERE SLUICED INTO POND D UNTIL 2003. FREE WATER IN POND D COVERS AN AREA OF APPROXIMATELY 28 ACRES. THE REMAINDER OF THE POND AREA IS VEGETATED WITH WEEDS AND BRUSH AND SMALL TREES. DRAINAGE FROM THE POND D WATERSHED IS BEING STORED IN POND D BEFORE IT CAN BE DISCHARGED TO A PERMITTED OUTFALL IN ACCORDANCE WITH VPDES PERMIT NO. VA0002071.

   c. POND E COVERS AN AREA OF APPROXIMATELY 38 ACRES. POND E WAS CONSTRUCTED IN 1967 AND WAS UTILIZED FOR CCR DISPOSAL UNTIL 2003. AS OF JUNE 2015, THE CCR IN POND E IS BEING DREDGED AND PLACED IN POND D IN ACCORDANCE WITH VPDES PERMIT NO. VA0002071. DRAINAGE FROM PONDS A, B, AND C IS BEING PUMPED TO POND D FOR STORAGE BEFORE IT CAN BE DISCHARGED IN ACCORDANCE WITH VPDES PERMIT NO. VA0002071.

3. ADJACENT AREAS:

THE PROPOSED SITE IS BOUNDED BY QUANTICO CREEK ON THE SOUTH AND AN UNNAMED TRIBUTARY OF QUANTICO CREEK ON THE WEST. EAST OF THE SITE IS COCKPIT POINT ROAD (ROUTE 783). TO THE NORTH OF THE SITE IS PRIVATE PROPERTY THAT IS HEAVILY WOODED. THE MAJORITY OF THE CONTRIBUTING DRAINAGE AREA INTO THE PONDS INCLUDE VEGETATED AREAS CONSISTING OF BRUSH AND FORESTLAND.

4. OFF-SITE AREAS:

SOIL BORROW AREAS WILL BE LOCATED WITHIN THE PROPERTY AND ARE COVERED UNDER THIS PLAN. THERE ARE NO OFF-SITE AREAS PROPOSED TO BE DISTURBED.

5. SOILS:

ACCORDING TO THE NRCS WEB SOIL SURVEY REPORT FOR THE PROJECT AREA, THE SOILS AT THE SITE CONTAIN MOSTLY HYDROLOGIC SOIL GROUP TYPE A AND TYPE B SOILS, WITH TYPE B SOILS BEING PREDOMINANT. A LESSER PORTION OF THE PROJECT CONSISTS OF TYPE D SOILS. TYPE A SOILS EXIST IN THE POND EMBANKMENTS AND AREAS IMMEDIATELY ADJACENT TO THE PONDS. TYPE B SOILS MAKE UP THE MAJORITY OF THE CONTRIBUTING DRAINAGE AREA UPLAND OF THE PONDS. GROUP A SOILS HAVE A HIGH INFILTRATION RATE AND LOW RUN-OFF POTENTIAL WHEN THOROUGHLY WETTED. THESE SOILS CONSIST MAINLY OF DEEP, WELL DRAINED TO EXCESSIVELY DRAINED SANDS OR GRAVELLY SANDS. THESE SOILS HAVE A HIGH RATE OF WATER TRANSMISSION (>0.3 IN/HR). GROUP B SOILS HAVE MODERATE INFILTRATION RATES WHEN THOROUGHLY WETTED AND CONSIST CHIEFLY OF MODERATELY DEEP TO DEEP, MODERATELY WELL TO WELL DRAINED SOILS WITH MODERATELY FINE TO MODERATELY COARSE TEXTURES. THESE SOILS HAVE A MODERATE RATE OF WATER TRANSMISSION (0.15–0.30 IN/HR). GROUP C SOILS HAVE LOW INFILTRATION RATES WHEN THOROUGHLY WETTED AND CONSIST CHIEFLY OF SOILS WITH LAYERS THAT IMPEDE DOWNWARD MOVEMENT OF WATER AND SOILS WITH MODERATELY FINE TO FINE TEXTURES. THESE SOILS HAVE A LOW RATE OF WATER TRANSMISSION (0.05–0.15 IN/HR). GROUP D SOILS HAVE HIGH RUNOFF POTENTIAL. THEY HAVE VERY LOW INFILTRATION RATES WHEN THOROUGHLY WETTED AND CONSISTS CHIEFLY OF CLAY SOILS WITH HIGH SWELLING POTENTIAL, A PERMANENT HIGH WATER TABLE, A CLAY PAN OR CLAY LAYER AT OR NEAR THE SURFACE, AND SHALLOW NEARLY IMPERVIOUS MATERIAL. THESE SOILS HAVE A LOW RATE OF TRANSMISSION (0–0.05 IN/HR).

6. CRITICAL AREAS:

SEVERAL LOCATIONS EXIST WHERE THE PROPOSED LIMITS OF DISTURBANCE (LOD) EXTEND TO WITHIN 10 FEET OF WETLAND AREAS AND THE FEMA FLOODPLAIN BOUNDARY. THE LOD ALSO ENCROACHES INTO THE RPA IN SEVERAL LOCATIONS. THESE ARE CONSIDERED CRITICAL AREAS DUE TO THE POTENTIAL DAMAGE OF SILTATION WITHIN THE WETLANDS, RPA, AND FLOODPLAIN. OTHER CRITICAL AREAS ON THE SITE INCLUDE STEEP SLOPE AREAS ASSOCIATED WITH THE POND EMBANKMENTS AND THE UPLAND PERIMETERS OF THE WORK AREA. THESE ARE CONSIDERED CRITICAL AREAS DUE TO THE INCREASED POTENTIAL FOR EROSION.

7. EROSION AND SEDIMENT CONTROL MEASURES:

UNLESS OTHERWISE INDICATED, ALL VEGETATIVE AND STRUCTURAL EROSION AND SEDIMENT CONTROL MEASURES SHALL BE CONSTRUCTED AND MAINTAINED ACCORDING TO THE MINIMUM STANDARDS AND SPECIFICATIONS OF THE VIRGINIA EROSION AND SEDIMENT CONTROL HANDBOOK AND VIRGINIA REGULATIONS 4VAC50-30 EROSION AND SEDIMENT CONTROL REGULATIONS.

STRUCTURAL PRACTICES:

8. TEMPORARY STONE CONSTRUCTION ENTRANCE – 3.02

A STONE PAD WILL BE INSTALLED AT POINTS OF VEHICULAR INGRESS AND EGRESS, TO REDUCE THE SOIL TRANSPORTED ONTO PUBLIC ROADS AND OTHER PAVED AREAS.

9. SILT FENCE – 3.05

SILT FENCES WILL BE CONSTRUCTED ALONG THE PERIMETER OF THE PROJECT TO INTERCEPT AND DETAIN RUN-OFF SEDIMENT FROM SMALL AREAS NOT BEING DIVERTED TO SEDIMENT BASINS OR OTHER STRUCTURAL CONTROLS. TO DECREASE FLOW VELOCITIES, SILT FENCES WILL ALSO BE CONSTRUCTED ALONG UPSTREAM AREAS OF THE SITE TO INHIBIT EROSION POTENTIAL. WIRE SUPPORTED SILT FENCE (SUPER SILT FENCE) IN TWO LAYERS WILL BE USED FOR PERIMETER RUNOFF AND FOR CRITICAL AREAS.

10. STORM DRAIN INLET PROTECTION – 3.07

AS NECESSARY, EXISTING STORM DRAIN INLETS WILL BE PROTECTED FROM RUN-OFF BY USE OF SILT FENCE, GRAVEL/WIRE MESH, OR CATCH BASIN INSERTS. PROTECTION IS LIMITED TO DRAINAGE AREAS NOT EXCEEDING ONE (1) ACRE AND IS NOT INTENDED TO CONTROL LARGE, CONCENTRATED STORMWATER FLOWS. THERE ARE NO NEW STORM DRAIN INLETS THAT ARE PROPOSED TO BE INSTALLED ON THE SITE.

11. CULVERT INLET PROTECTION – 3.08

A SEDIMENT FILTER INSTALLED AT THE INLET OF A STORM SEWER CULVERT TO PREVENT THE ENTERING, ACCUMULATING, OR TRANSFERRING OF SEDIMENT THROUGH THE CULVERT. THIS MEASURE ALSO ALLOWS FOR EROSION CONTROL TO BE IN PLACE DURING PHASES OF THE PROJECT WHERE ELEVATIONS AND DRAINAGE PATTERNS ARE CHANGING, AND WHERE ORIGINAL CONTROLS ARE INEFFECTIVE.

12. TEMPORARY DIVERSION DIKE – 3.09

A RIDGE OF COMPACTED SOIL WILL BE CONSTRUCTED AT THE TOP OR BASE OF A SLOPING DISTURBED AREA TO DIVERT OFF-SITE RUNOFF AWAY FROM UNPROTECTED SLOPES AND TO A STABILIZED OUTLET, OR TO DIVERT SEDIMENT-LADEN RUNOFF TO A SEDIMENT TRAPPING STRUCTURE.

13. TEMPORARY SEDIMENT TRAP – 3.13

TEMPORARY SEDIMENT TRAPS, SMALL PONDING AREAS, WILL BE CONSTRUCTED TO FILTER STORMWATER FROM THE SITE.

14. TEMPORARY SEDIMENT BASIN – 3.14

A TEMPORARY BARRIER OR DAM WITH A CONTROLLED STORMWATER RELEASE STRUCTURE WILL BE CONSTRUCTED TO FILTER STORMWATER FROM THE SITE.

15. STORMWATER CONVEYANCE CHANNELS – 3.17

PERMANENT CHANNELS, THAT CARRY CONCENTRATED FLOWS AND RESIST EROSION, WILL BE USED TO CONVEY STORMWATER TO SEDIMENT BASINS.

16. OUTLET PROTECTION – 3.18

RIPRAP CHANNEL SECTIONS AND/OR STILLING BASINS WILL BE INSTALLED BELOW STORM DRAIN OUTLETS TO DECREASE EROSION AND UNDER-CUTTING, AND REDUCE VELOCITIES BEFORE ENTERING RECEIVING CHANNELS.

17. ROCK CHECK DAMS – 3.20

SMALL, TEMPORARY STONE DAMS WILL BE INSTALLED AT SET INTERVALS THROUGHOUT CHANNELS TO REDUCE THE VELOCITY OF CONCENTRATED FLOWS, REDUCING THE EROSION OF THE CHANNELS.

18. SOIL STABILIZATION BLANKETS AND MATTING – 3.36

A PROTECTIVE BLANKET OR SOIL STABILIZATION MAT WILL BE INSTALLED FOR PREPARED PLANTING OF STEEP SLOPES AND CHANNELS.

19. VEGETATIVE PRACTICES:

TOPSOILING – 3.30

TOPSOIL WILL BE PRESERVED AND USED TO ESTABLISH A SUITABLE MEDIUM FOR VEGETATION, WHICH WILL BE USED TO STABILIZE DISTURBED AREAS.

TEMPORARY SEEDING – 3.31

RAPIDLY GROWING PLANTS, APPROPRIATE TO THE AREA, WILL BE APPLIED TO AREAS NOT RECEIVING FINAL GRADING FOR THIRTY (30) DAYS TO ONE (1) YEAR.

PERMANENT SEEDING – 3.32

PERMANENT VEGETATIVE COVER WILL BE APPLIED TO FINE GRADED AREAS OR AREAS THAT WILL BE LEFT DORMANT FOR 6 MONTHS OR MORE.

MULCHING – 3.35

PLANT RESIDUALS OR OTHER SUITABLE MATERIALS WILL BE APPLIED TO DISTURBED SURFACES TO PREVENT EROSION AND REDUCE OVERLAND FLOW VELOCITIES.

20. MANAGEMENT STRATEGIES:

1. CONSTRUCTION WILL BE SEQUENCED SO THAT GRADING OPERATIONS CAN BEGIN AND END AS QUICKLY AS POSSIBLE WITH APPROPRIATE EROSION CONTROL MEASURES IN-PLACE. SEE "SEQUENCE OF CONSTRUCTION" ON THIS SHEET FOR FURTHER DETAILS.
2. REFER TO THE "GENERAL EROSION AND SEDIMENT CONTROL NOTES" FOR ADDITIONAL INFORMATION ON THE SCHEDULING OF EROSION CONTROL MEASURES AND SEEDING.
3. AREAS WHICH ARE NOT TO BE DISTURBED WILL BE CLEARLY MARKED BY FLAGS, SIGNS, ETC.
4. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE INSTALLATION AND MAINTENANCE OF ALL EROSION AND SEDIMENT CONTROL PRACTICES.

21. PERMANENT AND TEMPORARY STABILIZATION:

SEEDING WILL BE IN ACCORDANCE WITH THE TEMPORARY AND PERMANENT CHARTS PROVIDED BELOW, UNLESS OTHERWISE NOTED IN THE TECHNICAL SPECIFICATIONS. PERMANENT OR TEMPORARY SOIL STABILIZATION SHALL BE APPLIED TO DENUDED AREAS WITHIN SEVEN (7) DAYS AFTER FINAL GRADE IS REACHED ON ANY PORTION OF THE SITE. TEMPORARY SOIL STABILIZATION SHALL BE APPLIED WITHIN SEVEN (7) DAYS TO DENUDED AREAS THAT MAY NOT BE AT FINAL GRADE BUT WILL REMAIN DORMANT FOR LONGER THAN FOURTEEN (14) DAYS. PERMANENT STABILIZATION SHALL BE APPLIED TO AREAS THAT ARE LEFT DORMANT FOR MORE THAN SIX (6) MONTHS.

22. STORMWATER MANAGEMENT:

THE STORMWATER MANAGEMENT SYSTEM HAS BEEN DESIGNED TO HANDLE THE 25-YR STORM PER APPLICABLE SOLID WASTE REGULATIONS AND PER COUNTY REQUIREMENTS. THE PERMANENT CONVEYANCE CHANNEL OVER THE EMBANKMENT OF POND D HAS BEEN DESIGNED TO CONTAIN THE PMF STORM, PER APPLICABLE VDCR DAM SAFETY REGULATIONS. THE POND D–E SYSTEM, AS WELL AS PONDS A, B, AND C, ARE DESIGNED TO DISCHARGE INTO TIDAL FLOODPLAINS, WITHIN WHICH WATER LEVELS ARE GOVERNED BY BACKWATER FROM THE POTOMAC RIVER. DUE TO THIS DISCHARGE CONDITION, AND PER DISCUSSION WITH PWC REPRESENTATIVES, STORMWATER QUANTITY MEASURES (I.E. STORMWATER BASINS) ARE NOT REQUIRED TO REDUCE THE PEAK RUNOFF RATE OR VOLUME. PERMANENT OUTLET STRUCTURES ARE DESIGNED TO INCORPORATE EROSION PROTECTION AND ENERGY DISSIPATION FOR THE 25-YEAR, 24-HOUR STORM, EXCEEDING THE REQUIREMENTS OF THE PWC DCSM FOR CHANNEL AND FLOOD PROTECTION. SEE THE HYDROLOGIC AND HYDRAULIC CALCULATION BOOKLET PREPARED FOR THIS EROSION AND SEDIMENT CONTROL PLAN FOR THE EXISTING CONDITIONS HYDROLOGY AND A PRE-DEVELOPMENT VS POST-DEVELOPMENT DISCHARGE COMPARISON AT THE DOWNSTREAM PROPERTY BOUNDARY STUDY POINT.

23. MAINTENANCE SCHEDULE:

ALL INSPECTIONS FOR THE SITE WILL BE MADE WEEKLY AND AFTER EACH RUNOFF PRODUCING RAIN EVENT. IN THE EVENT OF DAMAGE TO THE EROSION OR SEDIMENT CONTROL MEASURES, REPAIRS WILL BE MADE IMMEDIATELY. SEDIMENT TRAPPING DEVICES WILL BE CLEANED OUT WHEN SEDIMENT REACHES THE CLEANOUT POINT.

24. SOIL STOCKPILES AND BORROW AREAS:

SOIL WILL BE OBTAINED FROM ON-SITE BORROW AREAS AND WILL BE INCORPORATED INTO THE SUBGRADE AND THE CAP COVER SYSTEM. TOPSOIL WILL BE STORED IN TEMPORARY STOCKPILES FOR REDISTRIBUTION INTO THE FINAL SURFACE. EROSION AND SEDIMENT CONTROLS ASSOCIATED WITH THE TEMPORARY SOIL STOCKPILES AND BORROW AREAS WILL COMPLY WITH THE REQUIREMENTS OF THIS PLAN.

25. SEQUENCE OF CONSTRUCTION (SOC)

THE FOLLOWING IS A COMPILATION OF THE SOCS FOR THE CONSTRUCTION PROJECTS ANTICIPATED IN THE POND CLOSURE PLANS. THESE PROJECTS WILL GENERALLY OCCUR IN THE WRITTEN ORDER BELOW OVER THE NEXT 3 YEARS.

CONSTRUCTION ENTRANCES WILL BE CONSTRUCTED AS NEEDED. THE MAJORITY OF THE WORK WILL BE CONDUCTED WITHIN THE SITE. AS SUCH, VEHICLES MUST PASS OVER GRAVEL ROADS INTERIOR TO THE SITE PRIOR TO ENTERING PUBLIC ROADS AND AN EQUIPMENT WASH FACILITY WILL BE AVAILABLE FOR USE, IF NEEDED.

SURFACE IMPOUNDMENT E SOC:

ITEMS 1 THROUGH 6 ARE OPERATIONAL ACTIVITIES REGULATED UNDER VIRGINIA POLLUTANT DISCHARGE ELIMINATION SYSTEM (VPDES) INDUSTRIAL DISCHARGE PERMIT AND ARE NOT SUBJECT TO PRINCE WILLIAM COUNTY (PWC) SITE PLAN APPROVAL.

1. INSTALL TEMPORARY FACILITIES.
2. INSTALL WATER PUMPING SYSTEM TO PUMP WATER FROM POND E TO POND D.
3. DEWATER POND E.
4. BEGIN MECHANICALLY DREDGING CCR FROM POND E AND PLACE IN A TEMPORARY STOCKPILE IN POND D.
5. INSTALL WATER TREATMENT SYSTEM.
6. BEGIN INITIAL GRADING OF POND E, WITHIN THE LIMITS OF THE POND E EMBANKMENT.
7. PARTIALLY REMOVE POND E EMBANKMENT AND USE AS FILL WITHIN THE LIMITS OF POND E.
8. CONSTRUCT E&S CONTROLS AROUND POND E. CONSTRUCT TEMPORARY SEDIMENT BASIN (BASIN E-1).
9. INSTALL DRAINAGE CHANNELS WITHIN POND E, INCLUDING CHANNEL LININGS AND CHECK DAMS.
10. INSTALL DRAINAGE AND E&S CONTROLS FOR BORROW AREA 2.
11. DEVELOP BORROW AREA 2.
12. PLACE FILL AND COMPLETE FINAL GRADING OF THE POND E SURFACE, UPGRADIENT OF BASIN E-1.
13. ADD SOIL AMENDMENTS, SEED AND STABILIZE THE POND E SURFACE CONCURRENT WITH FINAL GRADING ACTIVITIES.
14. REMOVE TEMPORARY SEDIMENT BASIN (BASIN E-1).
15. REMOVE A PORTION OF THE POND E EMBANKMENT AND EXTEND DRAINAGE CHANNELS TO DISCHARGE OFFSITE.
16. ADD SOIL AMENDMENTS, SEED AND STABILIZE THE REGRADED BASIN E-1 SURFACE.
17. REMOVE PERIMETER CONTROLS FROM AROUND POND E UPON RECEIVING PERMISSION FROM THE PLAN APPROVING AUTHORITY.

PONDS A, B, AND C:

ITEMS 1 THROUGH 5 ARE OPERATIONAL ACTIVITIES REGULATED UNDER VPDES INDUSTRIAL DISCHARGE PERMIT AND ARE NOT SUBJECT TO PWC SITE PLAN APPROVAL.

1. INSTALL TEMPORARY FACILITIES.
2. INSTALL WATER PUMPING SYSTEM TO PUMP WATER FROM PONDS A, B, AND C TO POND D.
3. DEWATER PONDS A, B, AND C.
4. BEGIN MECHANICALLY DREDGING CCR FROM PONDS A, B, AND C AND PLACE IN A TEMPORARY STOCKPILE IN POND D.
5. BEGIN INITIAL GRADING OF PONDS A, B, AND C, WITHIN THE LIMITS OF PONDS A, B, AND C EMBANKMENT.
6. CONSTRUCT E&S CONTROLS AROUND PONDS A, B, AND C.
6. CONSTRUCT THE SANITARY SEWER FORCEMAIN RELOCATION.
7. EXCAVATE ANY REMAINING CCR FROM AREA WEST OF PONDS A, B, AND C AND HAUL CCR TO AN APPROVED OFFSITE DISPOSAL FACILITY, IF REQUIRED.
8. CONSTRUCT TEMPORARY SEDIMENT BASINS (BASIN B-1 AND BASIN C-1).
9. INSTALL DRAINAGE CHANNELS WITHIN PONDS A, B, AND C, INCLUDING CHANNEL LININGS AND CHECK DAMS.
10. IMPORT AND PLACE FILL, AND COMPLETE FINAL GRADING OF PONDS A, B, AND C SURFACES, UPGRADIENT OF BASIN B-1 AND BASIN C-1.
11. ADD SOIL AMENDMENTS, SEED AND STABILIZE PONDS A, B, AND C SURFACE CONCURRENT WITH FINAL GRADING ACTIVITIES.
12. REMOVE TEMPORARY SEDIMENT BASINS (BASIN B-1 AND BASIN C-1).
14. REMOVE A PORTION OF THE EMBANKMENTS FROM PONDS B AND C, AND EXTEND DRAINAGE CHANNELS TO DISCHARGE OFFSITE.
15. ADD SOIL AMENDMENTS, SEED AND STABILIZE THE REGRADED BASIN B-1 AND BASIN C-1 SURFACES.
16. REMOVE PERIMETER CONTROLS FROM AROUND PONDS A, B, AND C UPON RECEIVING PERMISSION FROM THE PLAN APPROVING AUTHORITY.

POND D SOC:

ITEMS 1 THROUGH 6 ARE OPERATIONAL ACTIVITIES REGULATED UNDER VPDES INDUSTRIAL DISCHARGE PERMIT AND ARE NOT SUBJECT TO PWC SITE PLAN APPROVAL.

1. CONSTRUCT PIPE/HOSE TO POND E TEMPORARY TREATMENT SYSTEM.
2. INSTALL WATER TREATMENT SYSTEM.
3. DRAIN SURFACE WATER TO POND E THROUGH TREATMENT SYSTEM.
4. CONSTRUCT E&S CONTROLS AROUND POND D EMBANKMENT.
5. DEWATER POND D – ACTIVE (WELL POINTS AND RIM DITCH AND UNDERDRAINS).
6. CUT LOW POINT OF POND D STORMWATER RUNOFF CHANNEL ALONG DAM EMBANKMENT.
7. INSTALL UNDERDRAIN TO PHASE 1 CONFIGURATION.
8. BORROW AREA NO. 1 DEVELOPMENT FOR POND D.
9. INSTALL GEOSYNTHETIC CLAY LINER ON SIDE SLOPES AS PHASE 1 FILL PROGRESSES.
10. GRADE AND FILL POND D SUBGRADE (PHASE 1) – WITH ASH FROM STOCKPILE (PONDS A, B, C, & E).
11. PARTIALLY REMOVE POND D EMBANKMENT FOR FILL.
12. GRADE AND FILL POND D SUBGRADE (PHASE 2) – WITH SOIL FILL FROM POND D EMBANKMENT AND BORROW 1.
13. INSTALL GEOSYNTHETIC CAP SYSTEM AS PHASE 2 PROGRESSES.
14. CONSTRUCT POND D PHASE 2 GRADING.
15. INSTALL SUB-SURFACE DRAIN SYSTEM AS PHASE 2 GRADING PROGRESSES.
16. INSTALL PHASE 2 CHANNEL LININGS.
17. ESTABLISH PHASE 2 VEGETATION.
18. COMPLETE GEOSYNTHETIC CAP SYSTEM DURING PHASE 3.
19. MODIFY POND D STORMWATER CHANNEL TO FINAL DESIGN CONFIGURATION.
20. CONSTRUCT POND D PHASE 3 GRADING.
21. COMPLETE CHANNEL LININGS.
22. ADD SOIL AMENDMENTS, SEED, AND STABILIZE.
23. REMOVE PERIMETER CONTROLS FROM AROUND POND D UPON RECEIVING PERMISSION FROM THE PLAN APPROVING AUTHORITY.

BORROW AREA NO. 1 SOC:

1. INSTALL PERIMETER EROSION CONTROLS (SUPER SILT FENCE AND SILT FENCE, CULVERT INLET PROTECTION, ETC.).
2. INITIATE CONSTRUCTION OF SEDIMENT BASIN PRIOR TO CONDUCTING BORROW OPERATIONS.
3. AFTER SEDIMENT BASIN RISER IS OPERATIONAL, EXCAVATE BORROW AREA TO DRAIN TOWARDS SEDIMENT BASIN.
4. COMPLETE EXCAVATION FOR BORROW AREA.
5. STABILIZE DENUDED AREAS.
6. REMOVE PERIMETER CONTROLS UPON RECEIVING PERMISSION FROM THE PLAN APPROVING AUTHORITY.
7. REMOVE SEDIMENT BASIN.

PRINCE WILLIAM COUNTY CHECKLIST NOTE [DPM, SECTION 405.3(B)(L)]

1. A PHASE 1 ARCHAEOLOGICAL SURVEY WAS COMPLETED FOR THE PROJECT AND SENT TO THE VIRGINIA DEPARTMENT OF HISTORIC RESOURCES. THE PHASE 1 ARCHAEOLOGICAL SURVEY DEMONSTRATES THERE ARE NO KNOWN CEMETERIES OR HISTORICAL SITES IN THE PROJECT AREA.

TEMPORARY SEEDING CHART (TYPICAL FOR ALL SHEETS)		
PLANTING DATES	SPECIES	RATE (lbs/acre)
SEPT. 1 - FEB. 15	50/50 MIX OF ANNUAL RYEGRASS AND WINTER RYE	75
FEB. 16 - APR. 30	ANNUAL RYEGRASS	60
MAY 1 - AUG. 31	GERMAN MILLET	50

PERMANENT SEEDING CHART (3:1 OR LESS) - AREAS OUTSIDE OF THE RPA AND RPA MITIGATION AREA	
SPECIES	RATE** (lbs/acre)
KENTUCKY 31 TALL FESCUE	128
RED TOP GRASS	2
SEASONAL NURSE CROP*	20

PERMANENT SEEDING CHART (STEEPER THAN 3:1) - AREAS OUTSIDE OF THE RPA AND RPA MITIGATION AREA	
SPECIES	RATE** (lbs/acre)
KENTUCKY 31 TALL FESCUE	108
COMMON BERMUDAGRASS***	7
RED TOP GRASS	2
SEASONAL NURSE CROP*	20
RED CLOVER	20

* USE SEASONAL NURSE CROP IN ACCORDANCE WITH SEEDING DATES AS STATED BELOW:

FEBRUARY - APRIL:	ANNUAL RYE
MAY - AUGUST:	FOXTAIL MILLET
SEPTEMBER - NOVEMBER 15:	ANNUAL RYE
NOVEMBER 16 - JANUARY:	WINTER RYE

** TOTAL RATE IS 150 lbs/acre

*** MAY THROUGH OCTOBER, USE HULLED SEED. ALL OTHER SEEDING PERIODS, USE UNHULLED.

NOTES:
1. WEEPING LOVEGRASS MAY BE ADDED TO ANY SLOPE OR LOW MAINTENANCE MIX DURING WARMER SEED PERIODS; ADD 10-20 lbs./acre IN MIXES.
2. SUBMIT RECOMMENDATION FROM CERTIFIED AGRICULTURALIST FOR SEEDING AND SOIL AMENDMENTS BASED ON TESTING OF VEGETATIVE SOIL.
3. UNLESS OTHERWISE INDICATED FROM SOIL-SPECIFIC ANALYSIS, SEED MIXTURES AND APPLICATION RATES SHALL BE IN ACCORDANCE WITH THESE PLANS.

PERMANENT SEEDING CHART - AREAS WITHIN THE RPA AND RPA MITIGATION AREA	
SPECIES	RATE** (lbs/acre)
INDIAN GRASS	45
VIRGINIA WILD RYE	22.5
BIG BLUESTEM	22.5
REDTOP PANICGRASS	15
SWITCHGRASS	7.5
PARTRIDGE PEA	7.5
AUTUMN BENTGRASS	7.5
BONESET	7.5
MISTFLOWER	3
COMMON SNEEZEWEED	3
MARYLAND SENNA (SENNA MARILANDICA)	3
WILD SENNA	1.5
SWAMP MILKWEED	1.5

** TOTAL RATE IS 150 lbs/acre

NOTES:
1. PERMANENT SEEDING WILL CONSIST OF A NATIVE MIXTURE SUCH AS LISTED ABOVE AND WILL BE APPLIED TO IMPACTED RPA AREAS AND RPA MITIGATION AREAS.
2. THE SEED APPLICATION RATES ARE SUBJECT TO CHANGE BASED ON TESTING OF VEGETATIVE SOIL.
3. SUBMIT RECOMMENDATION FROM CERTIFIED AGRICULTURALIST FOR SEEDING AND SOIL AMENDMENTS BASED ON TESTING OF VEGETATIVE SOIL.
4. SERICEA LESPEDEZA WILL NOT BE APPLIED AT THE SITE DURING ANY SEEDING APPLICATION.

MULCHES	RATES: PER ACRE	RATES: PER 1000 SQ. FT.	NOTES:
STRAW AND HAY	1 1/2 - 2 TONS (MINIMUM 2 TONS FOR WINTER COVER)	70 - 90 lbs.	FREE FROM WEEDS AND COARSE MATTER. MUST BE ANCHORED. SPREAD WITH MULCH BLOWER OR BY HAND.
FIBER MULCH	MINIMUM 1500 lbs.	35 lbs.	DO NOT USE AS MULCH FOR WINTER COVER OR DURING HOT, DRY PERIODS.* APPLY AS SLURRY.

* WHEN FIBER MULCH IS THE ONLY AVAILABLE MULCH DURING PERIODS WHEN STRAW SHOULD BE USED, APPLY AT A MINIMUM RATE OF 2000 lbs./ac. OR 45 lbs./1000 SQ.FT.

LIME AND FERTILIZER	RATES: PER ACRE	RATES: PER 1,000 SQ. FT.	NOTES:
LIME	2 TONS	90 LBS.	AGRICULTURAL GRADE LIMESTONE
FERTILIZER	1,000 LBS.	23 LBS.	10-20-10

LIME AND FERTILIZER SHALL BE INCORPORATED INTO THE TOP 4-6 INCHES OF SOIL BY DISCING.

SUBMIT RECOMMENDATION FROM CERTIFIED AGRICULTURALIST FOR SEEDING AND SOIL AMENDMENTS BASED ON TESTING OF VEGETATIVE SOIL.

NO.	DATE	DWN	CHK	APP	DESCRIPTION

REVISION RECORD

DRAWING TITLE: GENERAL NOTES

PROJECT: POSSUM POINT POWER STATION COAL COMBUSTION RESIDUAL SURFACE IMPOUNDMENT CLOSURES DUMFRIES, VA

gai consultants

CLIENT: VIRGINIA ELECTRIC AND POWER COMPANY GLEN ALLEN, VA

ISSUING OFFICE: Richmond | 4198 Cox Road, Suite 114, Glen Allen, VA 23060

COMMONWEALTH OF VIRGINIA
JOHN R. KLAMUT
Lic. No. 036534
11/18/2015
PROFESSIONAL ENGINEER

DRAWN BY:	CHECKED BY:	APPROVED BY:
DOYLEMP	KINDEKW	KLAMUJR
DWG TYPE	SCALE	ISSUE DATE:
	N/A	11/18/2015

SHEET NO.: 2 OF 65

REVISION:

GAI FILE NUMBER: C150132-00-000-C-D1-002

ALT./CLIENT DRAWING NUMBER:

GAI DRAWING NUMBER: 002

PERMIT

1992

CHECKLIST

FOR EROSION AND SEDIMENT CONTROL PLANS

X Minimum Standards - All applicable Minimum Standards must be addressed.

NARRATIVE

X Project description - Briefly describes the nature and purpose of the land-disturbing activity, and the area (acres) to be disturbed.
SEE SHEET 002, IN E&SC NARRATIVE SECTION PROJECT DESCRIPTION

X Existing site conditions - A description of the existing topography, vegetation and drainage. SEE SHEET 002, IN E&SC NARRATIVE SECTION EXISTING CONDITIONS

X Adjacent areas - A description of neighboring areas such as streams, lakes, residential areas, roads, etc., which might be affected by the land disturbance.
SEE SHEET 002, IN E&SC NARRATIVE SECTION ADJACENT AREAS

N/A Off-site areas - Describe any off-site land-disturbing activities that will occur (including borrow sites, waste or surplus areas, etc.). Will any other areas be disturbed? OFF-SITE AREAS ARE NOT ANTICIPATED TO BE DISTURBED

X Soils - A brief description of the soils on the site giving such information as soil name, mapping unit, erodibility, permeability, depth, texture and soil structure. SEE SHEET 002, IN E&SC NARRATIVE SECTION SOILS

X Critical areas - A description of areas on the site which have potentially serious erosion problems (e.g., steep slopes, channels, wet weather/underground springs, etc.). SEE SHEET 002, IN E&SC NARRATIVE SECTION CRITICAL AREAS

X Erosion and sediment control measures - A description of the methods which will be used to control erosion and sedimentation on the site. (Controls should meet the specifications in Chapter 3.)
SEE SHEET 002, IN E&SC NARRATIVE SECTION E&SC MEASURES.
SEE SHEET 002, IN E&SC NARRATIVE SECTION STRUCTURAL PRACTICES, SEE SHEET 11 THROUGH SHEET 45
SEE SHEET 002, IN E&SC NARRATIVE SECTION VEGETATIVE PRACTICES, SEE SHEET 11 THROUGH SHEET 45.

X Permanent stabilization - A brief description, including specifications, of how the site will be stabilized after construction is completed.
SEE SHEET 002, IN E&SC NARRATIVE SECTION PERMANENT AND TEMPORARY STABILIZATION.

X Stormwater runoff considerations - Will the development site cause an increase in peak runoff rates? Will the increase in runoff cause flooding or channel degradation downstream? Describe the strategy to control stormwater runoff. SEE SHEET 002; IN E&SC NARRATIVE SECTION STORMWATER MANAGEMENT
SEE SHEET 002; IN GENERAL E&SC NOTES, NOTE 30.

X Calculations - Detailed calculations for the design of temporary sediment basins, permanent stormwater detention basins, diversions, channels, etc. Include calculations for pre- and post-development runoff.

1992

Checklist (continued)

SITE PLAN

X Vicinity map - A small map locating the site in relation to the surrounding area. Include any landmarks which might assist in locating the site.
SEE SHEET 001

X Indicate north - The direction of north in relation to the site.
INCLUDED ON PLAN SHEETS

X Limits of clearing and grading - Areas which are to be cleared and graded.
THE PLANNED LIMITS OF DISTURBANCE ARE SHOWN ON THE PLAN SHEETS.

X Existing contours - The existing contours of the site.
TYPICAL OF PLAN SHEETS

X Final contours - Changes to the existing contours, including final drainage patterns.
TYPICAL OF PLAN SHEETS

X Existing vegetation - The existing tree lines, grassed areas, or unique vegetation.
TYPICAL OF PLAN SHEETS

X Soils - The boundaries of different soil types.
SEE SHEETS 056 THROUGH 059

X Existing drainage patterns - The dividing lines and the direction of flow for the different drainage areas. Include the size (acreage) of each drainage area.
SEE SHEET 056 THROUGH SHEET 059

X Critical erosion areas - Areas with potentially serious erosion problems. (See Chapter 6 for criteria.) AREAS LISTED UNDER CRITICAL AREAS IN E&SC NARRATIVE
TYPICAL AMONG SHEET 11 THROUGH SHEET 45

X Site Development - Show all improvements such as buildings, parking lots, access roads, utility construction, etc.
TYPICAL OF PLAN DRAWINGS, SEE SHEET 004 THROUGH SHEET 045

X Location of practices - The locations of erosion and sediment controls and stormwater management practices used on the site. Use the standard symbols and abbreviations in Chapter 3 of this handbook.
SEE SHEET 011 THROUGH SHEET 045

N/A Off-site areas - Identify any off-site land-disturbing activities (e.g., borrow sites, waste areas, etc.). Show location of erosion controls. (Is there sufficient information to assure adequate protection and stabilization?)
OFF-SITE AREAS ARE NOT ANTICIPATED

X Detail drawings - Any structural practices used that are not referenced to the E&S handbook or local handbooks should be explained and illustrated with detail drawings.
SEE SHEET 050 THROUGH SHEET 055

X Maintenance - A schedule of regular inspections and repair of erosion and sediment control structures should be set forth.
SEE SHEET 002, IN E&SC NARRATIVE SECTION MAINTENANCE SCHEDULE
SEE SHEET 002, GENERAL NOTES, NOTES 10, 11, & 15

NOTES REGARDING BALD EAGLE BUFFERS:

1. ACCESS TO POND E IS RESTRICTED TO THOSE AREAS OUTSIDE OF THE PROTECTIVE 660' BALD EAGLE BUFFER. THIS WOULD INCLUDE EQUIPMENT ENTRY TO AND EXIT FROM THE POND, EQUIPMENT REFUELING AND ASSOCIATED MAINTENANCE/REPAIR IF NECESSARY.
2. EQUIPMENT MOVEMENT WITHIN POND E IS RESTRICTED TO THOSE AREAS OUTSIDE OF THE PROTECTIVE 660' BALD EAGLE BUFFER. THE ONLY EXCEPTION TO THIS REQUIREMENT WILL ALLOW FOR A LIMITED PRESENCE INSIDE THE 660' BUFFER, ESTIMATED TO OCCUR NO CLOSER THAN 420' TO THE NEST, NECESSARY TO REACH THIS AREA OF THE POND. THIS WORK INSIDE THE BUFFER MUST BE SEQUENCED TO BEGIN AFTER TREE LEAF OUT TO PROVIDE AN ENHANCED NOISE AND VISUAL BUFFER.
3. ACCESS TO POND D IS RESTRICTED TO THOSE AREAS OUTSIDE OF THE PROTECTIVE 660' BALD EAGLE BUFFER. THIS WOULD INCLUDE EQUIPMENT ENTRY TO AND EXIT FROM THE POND, EQUIPMENT REFUELING AND ASSOCIATED MAINTENANCE/REPAIR IF NECESSARY.
4. EQUIPMENT MOVEMENT WITHIN POND D IS LARGELY RESTRICTED TO THOSE AREAS OUTSIDE OF THE PROTECTIVE 660' BALD EAGLE BUFFER. NOTIFICATION SHALL BE PROVIDED TO ENVIRONMENTAL BIOLOGY PRIOR TO INITIATING WORK ACTIVITIES WITHIN THE 330' AND 660' BUFFER ZONE OF POND D. WORK WITHIN THE 660' ZONE SHOULD ALSO, AS MUCH AS REASONABLY POSSIBLE, BE SCHEDULED TO OCCUR DURING THE NON-BREEDING SEASON FROM JULY 16 – DECEMBER 14. WORK IS NOT PERMITTED WITHIN THE 330' BUFFER ZONE DURING THE BREEDING SEASON.
5. ANY STAGING OF EQUIPMENT, FACILITIES OR MATERIALS ON THE SITE IS RESTRICTED TO THOSE AREAS OUTSIDE OF THE PROTECTIVE 660' BALD EAGLE BUFFERS ASSOCIATED WITH PONDS E AND D.

GEOTECHNICAL NOTE:

1. A GEOTECHNICAL REPORT IS NOT REQUIRED FOR THE PRINCE WILLIAM COUNTY SITE PLAN SUBMITTAL. A GEOTECHNICAL EXPLORATION AND TESTING PROGRAM HAS BEEN COMPLETED AND A GEOTECHNICAL REPORT HAS BEEN PREPARED FOR SUBMISSION TO OTHER AGENCIES, AS REQUIRED.

PROPOSED EROSION AND SEDIMENT CONTROL LEGEND

SF	SILT FENCE	SF
SSF	SUPER SILT FENCE	SSF SSF
IP	STORM DRAIN INLET PROTECTION	
CIP	CULVERT INLET PROTECTION	
ST	TEMPORARY SEDIMENT TRAP	
SB	TEMPORARY SEDIMENT BASIN	
SCC	STORMWATER CONVEYANCE CHANNEL	
OP	OUTLET PROTECTION	
B/M	SOIL STABILIZATION BLANKETS AND MATTING	
TO	TOPSOILING	
TS	TEMPORARY SEEDING	
PS	PERMANENT SEEDING	
MU	MULCHING	
CD	ROCK CHECK DAM	
DD	TEMPORARY DIVERSION DIKE	
RR	RIPRAP	
SAF	SAFETY FENCE	CF CF
CE	CONSTRUCTION ENTRANCE	
	LIMITS OF DISTURBANCE	LOD LOD

LIST OF ABBREVIATIONS

ABBREVIATION	DEFINITION
CCR	COAL COMBUSTION RESIDUALS
V.P.D.E.S.	VIRGINIA POLLUTANT DISCHARGE ELIMINATION SYSTEM
BMP	BEST MANAGEMENT PRACTICE
V.E.S.C.H.	VIRGINIA EROSION & SEDIMENT CONTROL HANDBOOK
SSD	SUBSURFACE DRAIN
QC	QUALITY CONTROL
UD	UNDERDRAIN
AR	ACCESS ROAD
VDOT	VIRGINIA DEPARTMENT OF TRANSPORTATION
CQC	CONSTRUCTION QUALITY CONTROL
ADS	ADVANCED DRAINAGE SYSTEMS
SDR	STANDARD DIMENSION RATIO
HDPE	HIGH-DENSITY POLYETHYLENE
LLDPE	LOW LINEAR-DENSITY POLYETHYLENE
GCL	GEOSYNTHETIC CLAY LINER
GDN	GEOSYNTHETIC DRAINAGE NET
CCM	CELLULAR CONCRETE MAT

PLAN REVIEW MINIMUM STANDARD CHECKLIST

YES NO NA

- X [ ] [ ] MS-1 Have temporary and permanent stabilization been addressed in narrative?
- X [ ] [ ] Are practices shown on the plan? SEE SHEET 11 THROUGH SHEET 45
- X [ ] [ ] Seed specifications? SEE SHEET 002 IN E&SC NARRATIVE SECTION VEGETATIVE PRACTICE
- X [ ] [ ] Mulching? SEE SHEET 002 IN E&SC NARRATIVE SECTION VEGETATIVE PRACTICE
- X [ ] [ ] Gravel?
  SEE SHEET 11 THROUGH 45 ROADS, INLET PROTECTION, OUTLET PROTECTION, AND RIPRAP
- X [ ] [ ] MS-2 Has stabilization of soil stockpiles been addressed in narrative?
- X [ ] [ ] Are sediment trapping measures provided? SEE SHEET 002 IN GENERAL E&SC NOTES, NOTE 17
  SEE SHEET 002 IN GENERAL E&SC NOTES, NOTES 10, 12, AND 13
- X [ ] [ ] MS-3 Has maintenance of permanent stabilization been addressed?
  SEE SHEET 002 IN GENERAL E&SC NOTES, NOTE 19
- X [ ] [ ] MS-4 Are sediment trapping facilities to be constructed as a first step in LDA?
- X [ ] [ ] Has maintenance of practices been addressed? (i.e. repair of practices and removal of accumulated sediment)
  SEE SHEET 002 IN GENERAL E&SC NOTES, NOTES 10 AND 12
- X [ ] [ ] MS-5 Has stabilization of earthen structures been addressed?
  SEE SHEET 002 IN GENERAL E&SC NOTES, NOTE 15
- X [ ] [ ] MS-6 Are sediment basins required where needed?
  SEE SHEET 002 IN GENERAL E&SC NOTES, NOTE 12
- X [ ] [ ] MS-7 Has stabilization of cut and fill slopes been adequately addressed?
  SEE SHEET 002 IN GENERAL E&SC NOTES, NOTE 20
- X [ ] [ ] MS-8 Are paved flumes, channels, or slope drains required where necessary?
  SEE SHEET 002 IN GENERAL E&SC NOTES, NOTE 21
- X [ ] [ ] MS-9 Have water seeps from slope face, adequate drainage or other protection addressed?
  SEE SHEET 002 IN GENERAL E&SC NOTES, NOTE 22
- X [ ] [ ] MS-10 Is adequate inlet protection provided on all operational storm sewer inlets?
  SEE SHEET 002 IN GENERAL E&SC NOTES, NOTE 23
- X [ ] [ ] MS-11 Are channel lining and/or outlet protection required on stormwater conveyance channels?
  SEE SHEET 002 IN GENERAL E&SC NOTES, NOTE 24
- X [ ] [ ] MS-12 Are in-stream construction measures required so that channel damage is minimized?
  SEE SHEET 002 IN GENERAL E&SC NOTES, NOTE 25
- X [ ] [ ] MS-13 Are temporary stream crossings of non-erodible material required where necessary?
  SEE SHEET 002 IN GENERAL E&SC NOTES, NOTE 26
- X [ ] [ ] MS-14 Are all applicable federal, state and local regulations pertaining to working in or crossing live watercourses being met?
  SEE SHEET 002 IN GENERAL E&SC NOTES, NOTE 27
- X [ ] [ ] MS-15 Has re-stabilization of areas subject to in-stream construction been adequately addressed?
  SEE SHEET 002 IN GENERAL E&SC NOTES, NOTE 28
- X [ ] [ ] MS-16 Has stabilization of utility trenches been addressed?
  SEE SHEET 002 IN GENERAL E&SC NOTES, NOTE 29
- X [ ] [ ] MS-17 Has the prevention of transporting of soil and mud onto public roadways been adequately addressed? (i.e. Construction Entrances, Wash Racks, daily cleaning of roadways, transport of sediment to a trapping facility.)
  SEE SHEET 002 IN GENERAL E&SC NOTES, NOTE 30
- X [ ] [ ] MS-18 Has the removal of temporary practices been addressed?
  SEE SHEET 002 IN GENERAL E&SC NOTES, NOTE 15
- X [ ] [ ] MS-19 Are properties and waterways downstream from the development adequately protected from erosion and sediment deposition due to increases in peak stormwater runoff?
  SEE SHEET 002 IN GENERAL E&SC NOTES, NOTE 30

EXISTING LEGEND

BM1

PROPOSED (PROP.) LEGEND

20	MAJOR CONTOUR
18	MINOR CONTOUR
X X X	FENCE
	PIPE (AS SPECIFIED ON PLANS)
	SPILLWAY OUTLET PIPE/CULVERT
SSD SSD	SUBSURFACE DRAIN
UD UD UD	UNDERDRAIN
	FORCEMAIN SEWERLINE
	CHANNEL (SEE SHEET 38)
	LIMITS OF PROPOSED (PROP.) GEOSYNTHETIC CAP SYSTEM
	GUARDRAIL
	CLEANOUT
	OUTLET PROTECTION
RR	RIPRAP SLOPE PROTECTION
	TEMPORARY BASIN AREA
	SECTION INDICATORS
	COMMON FILL
	GRAVEL ACCESS ROAD
EL:117.68	PROP. SPOT ELEVATION
	PROP. SETTLING MONUMENT

DRAWING TITLE: PROJECT CHECKLISTS AND LEGENDS

PROJECT: POSSUM POINT POWER STATION COAL COMBUSTION RESIDUAL SURFACE IMPOUNDMENT CLOSURES DUMFRIES, VA

gai consultants

CLIENT: VIRGINIA ELECTRIC AND POWER COMPANY GLEN ALLEN, VA

ISSUING OFFICE: Richmond | 4198 Cox Road, Suite 114, Glen Allen, VA 23060

NO.	DATE	DWN	CHK	APV	DESCRIPTION

REVISION RECORD

COMMONWEALTH OF VIRGINIA — JOHN R. KLAMUT Lic. No. 046859 — 11/18/2015 — PROFESSIONAL ENGINEER

DRAWN BY	CHECKED BY	APPROVED BY
DOYLEMP	KINDEKW	KLAMUJR
DWG TYPE	SCALE	ISSUE DATE
	N/A	11/18/2015

SHEET NO.: 3 OF 65 — REVISION: △

GAI FILE NUMBER: C150132-00-000-C-D1-002

ALT./CLIENT DRAWING NUMBER:

GAI DRAWING NUMBER: 003

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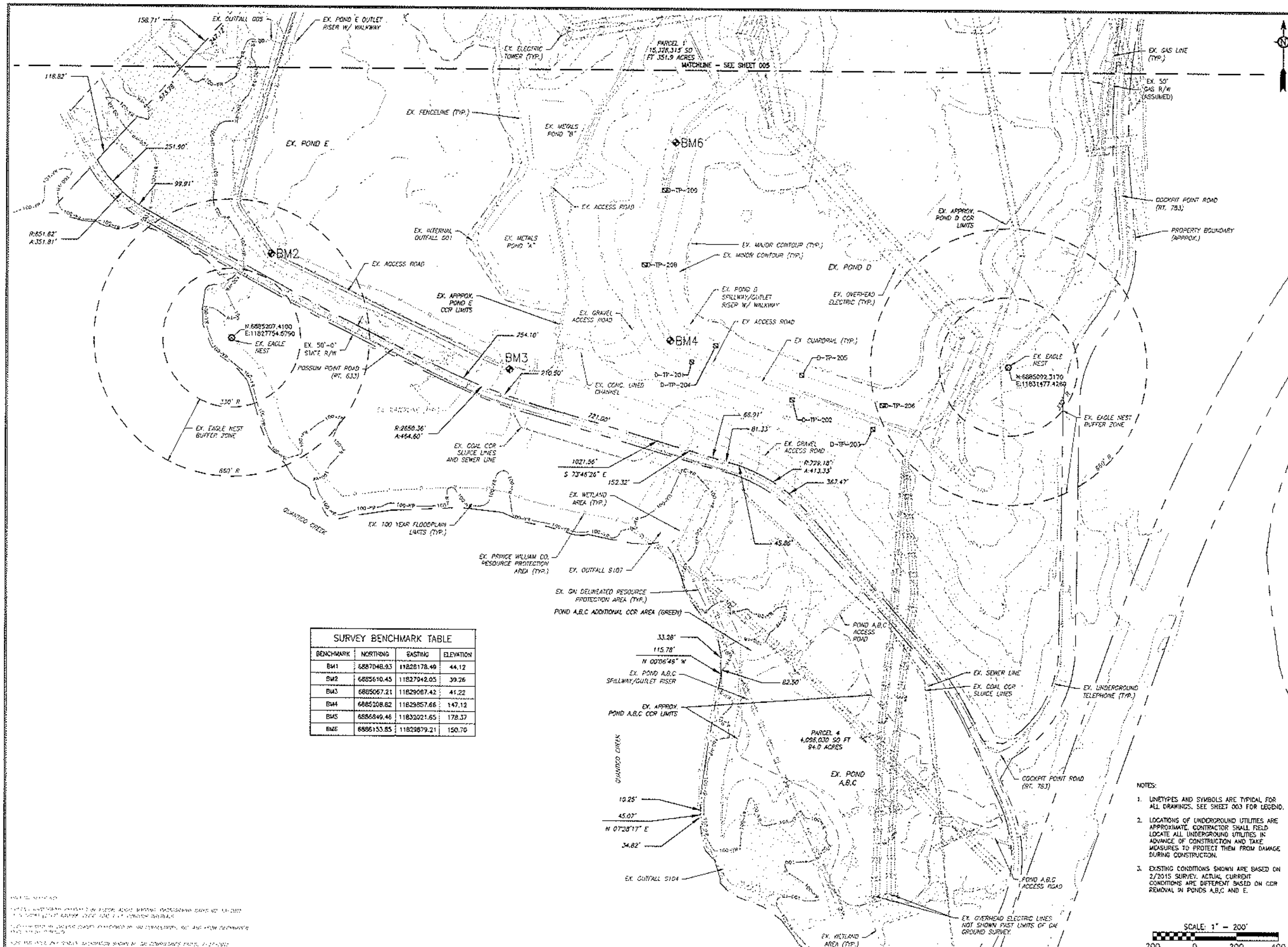

SURVEY BENCHMARK TABLE			
BENCHMARK	NORTHING	EASTING	ELEVATION
BM1	6887048.93	11828178.49	44.12
BM2	6885610.45	11827942.05	39.26
BM3	6885067.21	11829087.42	41.22
BM4	6885208.82	11829857.66	147.12
BM5	6886849.46	11832021.65	178.37
BM6	6886153.85	11829879.21	150.70

NOTES:

1. LINETYPES AND SYMBOLS ARE TYPICAL FOR ALL DRAWINGS. SEE SHEET 003 FOR LEGEND.
2. LOCATIONS OF UNDERGROUND UTILITIES ARE APPROXIMATE. CONTRACTOR SHALL FIELD LOCATE ALL UNDERGROUND UTILITIES IN ADVANCE OF CONSTRUCTION AND TAKE MEASURES TO PROTECT THEM FROM DAMAGE DURING CONSTRUCTION.
3. EXISTING CONDITIONS SHOWN ARE BASED ON 2/2015 SURVEY. ACTUAL CURRENT CONDITIONS ARE DIFFERENT BASED ON CCR REMOVAL IN PONDS A,B,C AND E.

SCALE: 1" = 200'

200 0 200 400

DRAWING TITLE
EXISTING CONDITIONS PLAN (1 OF 2)

PROJECT
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA

gai consultants

CLIENT
VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA

NO.	DATE	DWN	CHK	APV	DESCRIPTION

REVISION RECORD

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DOYLEMP	KINDEKW	KLAMUIJR
DWG TYPE	SCALE	ISSUE DATE
	AS SHOWN	11/18/2015

SHEET NO.: 4 OF 65

REVISION

GAI FILE NUMBER: C150132-00-000-C-D1-004

ALT./CLIENT DRAWING NUMBER:

GAI DRAWING NUMBER: 004

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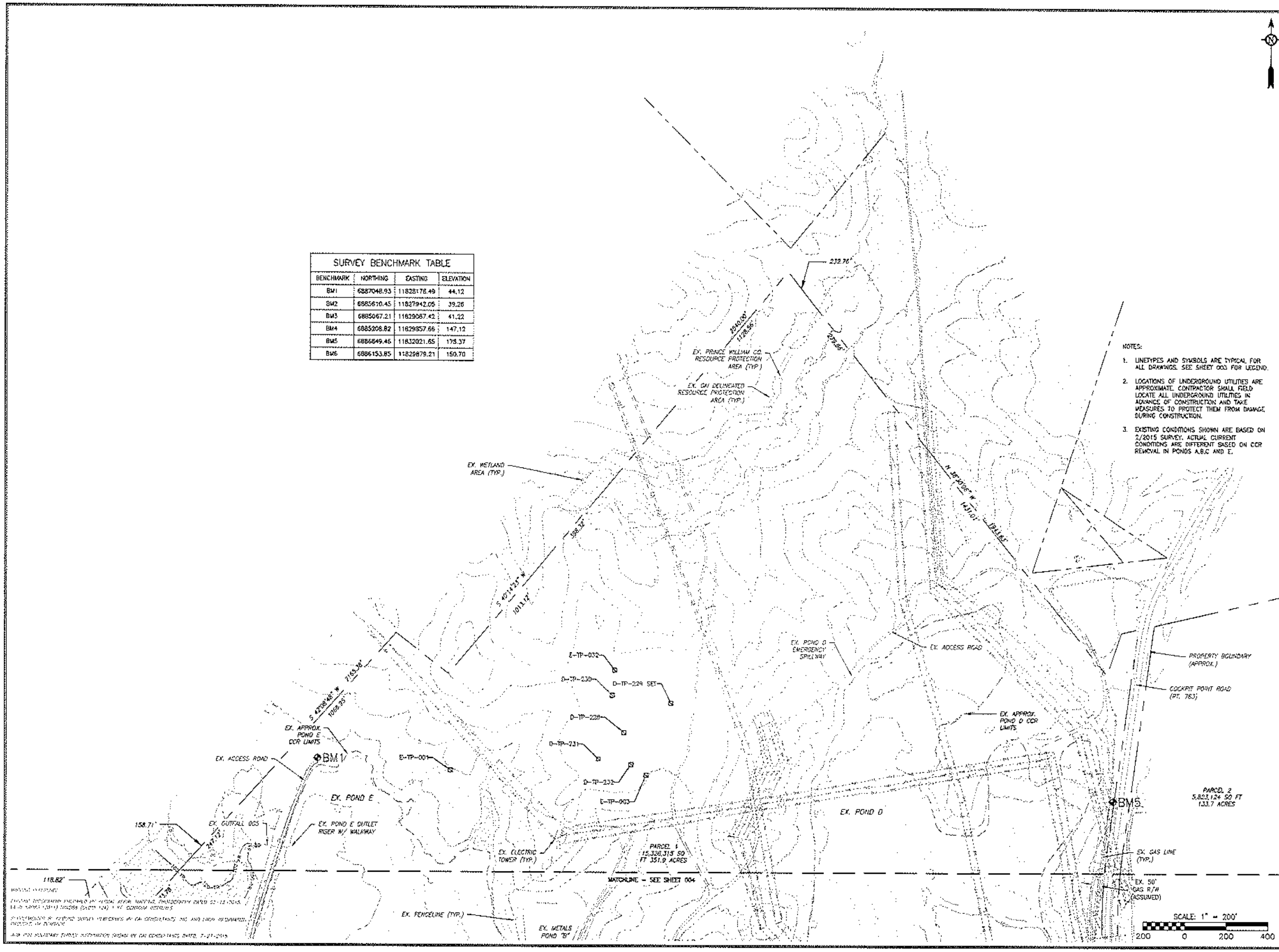

SURVEY BENCHMARK TABLE			
BENCHMARK	NORTHING	EASTING	ELEVATION
BM1	6887048.93	11828178.49	44.12
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BM6	6886153.85	11829879.21	150.70

NOTES:

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2. LOCATIONS OF UNDERGROUND UTILITIES ARE APPROXIMATE. CONTRACTOR SHALL FIELD LOCATE ALL UNDERGROUND UTILITIES IN ADVANCE OF CONSTRUCTION AND TAKE MEASURES TO PROTECT THEM FROM DAMAGE DURING CONSTRUCTION.
3. EXISTING CONDITIONS SHOWN ARE BASED ON 2/2015 SURVEY. ACTUAL CURRENT CONDITIONS ARE DIFFERENT BASED ON CCR REMOVAL IN PONDS A,B,C AND E.

DRAWING TITLE: EXISTING CONDITIONS PLAN (2 OF 2)

PROJECT: POSSUM POINT POWER STATION COAL COMBUSTION RESIDUAL SURFACE IMPOUNDMENT CLOSURES DUMFRIES, VA

gai consultants

CLIENT: VIRGINIA ELECTRIC AND POWER COMPANY GLEN ALLEN, VA

DRAWN BY:	CHECKED BY:	APPROVED BY:
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DWG TYPE:	SCALE:	ISSUE DATE:
	AS SHOWN	11/18/2015

SHEET NO.: 5 OF 65

GAI FILE NUMBER: C150132-00-000-C-D1-004

GAI DRAWING NUMBER: 005

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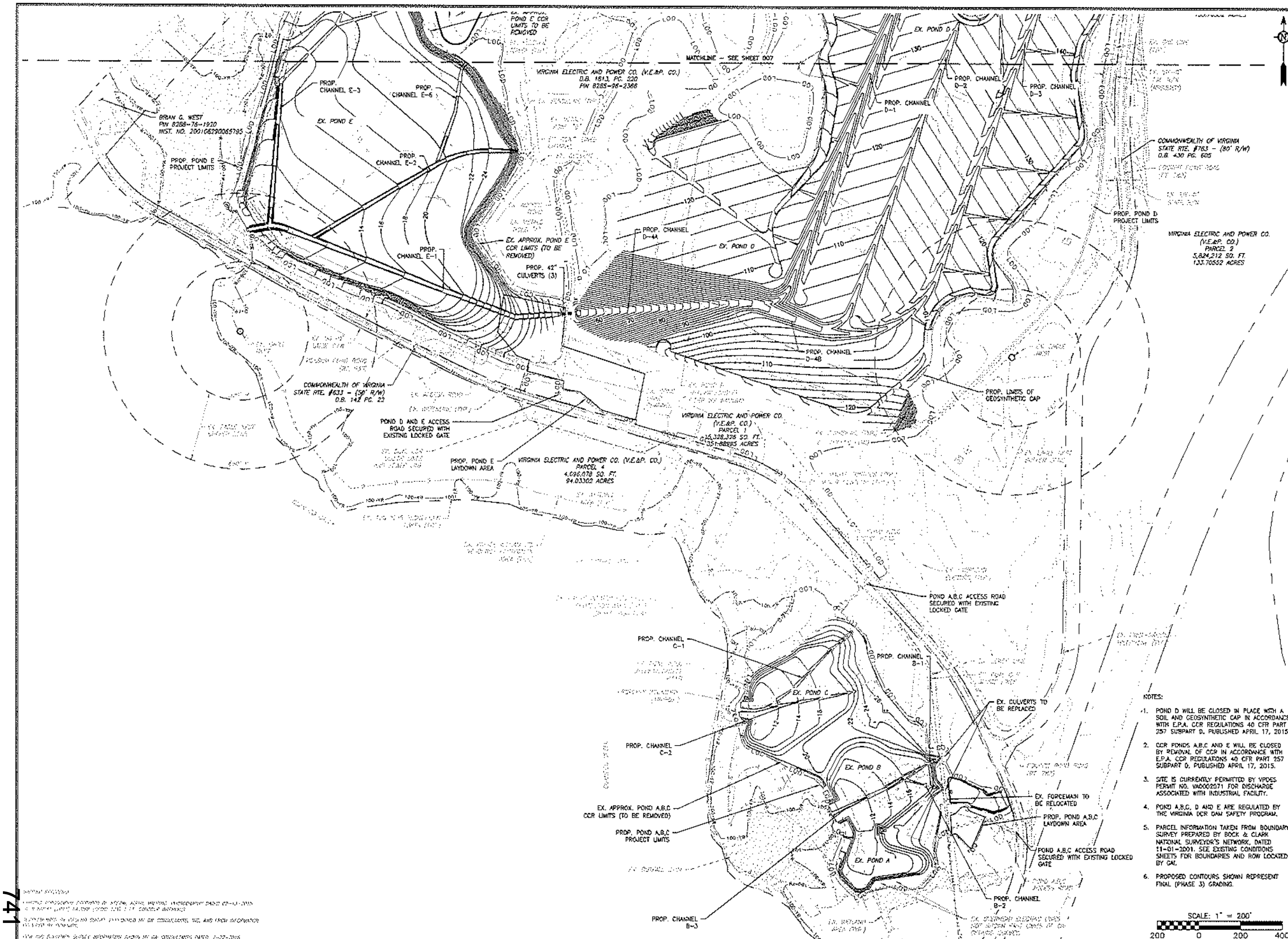


NOTES:

1. POND D WILL BE CLOSED IN PLACE WITH A SOIL AND GEOSYNTHETIC CAP IN ACCORDANCE WITH E.P.A. CCR REGULATIONS 40 CFR PART 257 SUBPART D, PUBLISHED APRIL 17, 2015.
2. CCR PONDS A,B,C AND E WILL BE CLOSED BY REMOVAL OF CCR IN ACCORDANCE WITH E.P.A. CCR REGULATIONS 40 CFR PART 257 SUBPART D, PUBLISHED APRIL 17, 2015.
3. SITE IS CURRENTLY PERMITTED BY VPDES PERMIT NO. VA0002071 FOR DISCHARGE ASSOCIATED WITH INDUSTRIAL FACILITY.
4. POND A,B,C, D AND E ARE REGULATED BY THE VIRGINIA DCR DAM SAFETY PROGRAM.
5. PARCEL INFORMATION TAKEN FROM BOUNDARY SURVEY PREPARED BY BOCK & CLARK NATIONAL SURVEYOR'S NETWORK, DATED 11-01-2001. SEE EXISTING CONDITIONS SHEETS FOR BOUNDARIES AND ROW LOCATED BY GAI.
6. PROPOSED CONTOURS SHOWN REPRESENT FINAL (PHASE 3) GRADING.

SCALE: 1" = 200'

200 0 200 400

NO.	DATE	DWN.	CHK.	APV.	DESCRIPTION

REVISION RECORD

DRAWING TITLE
SITE MASTER/ACCESS PLAN (1 OF 2)

PROJECT
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA

gai consultants

CLIENT
VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA

ISSUING OFFICE: Richmond | 4198 Cox Road, Suite 114, Glen Allen, VA 23060

COMMONWEALTH OF VIRGINIA
JOHN R. KLAMUT
11/18/2015
PROFESSIONAL ENGINEER

DRAWN BY:	CHECKED BY:	APPROVED BY:
DOYLEMP	KINDEKW	KLAMUJR
DWG TYPE:	SCALE:	ISSUE DATE:
	AS SHOWN	11/18/2015

SHEET NO.: 6 OF 65

REVISION: △

GAI FILE NUMBER: C150132-00-000-C-D1-006

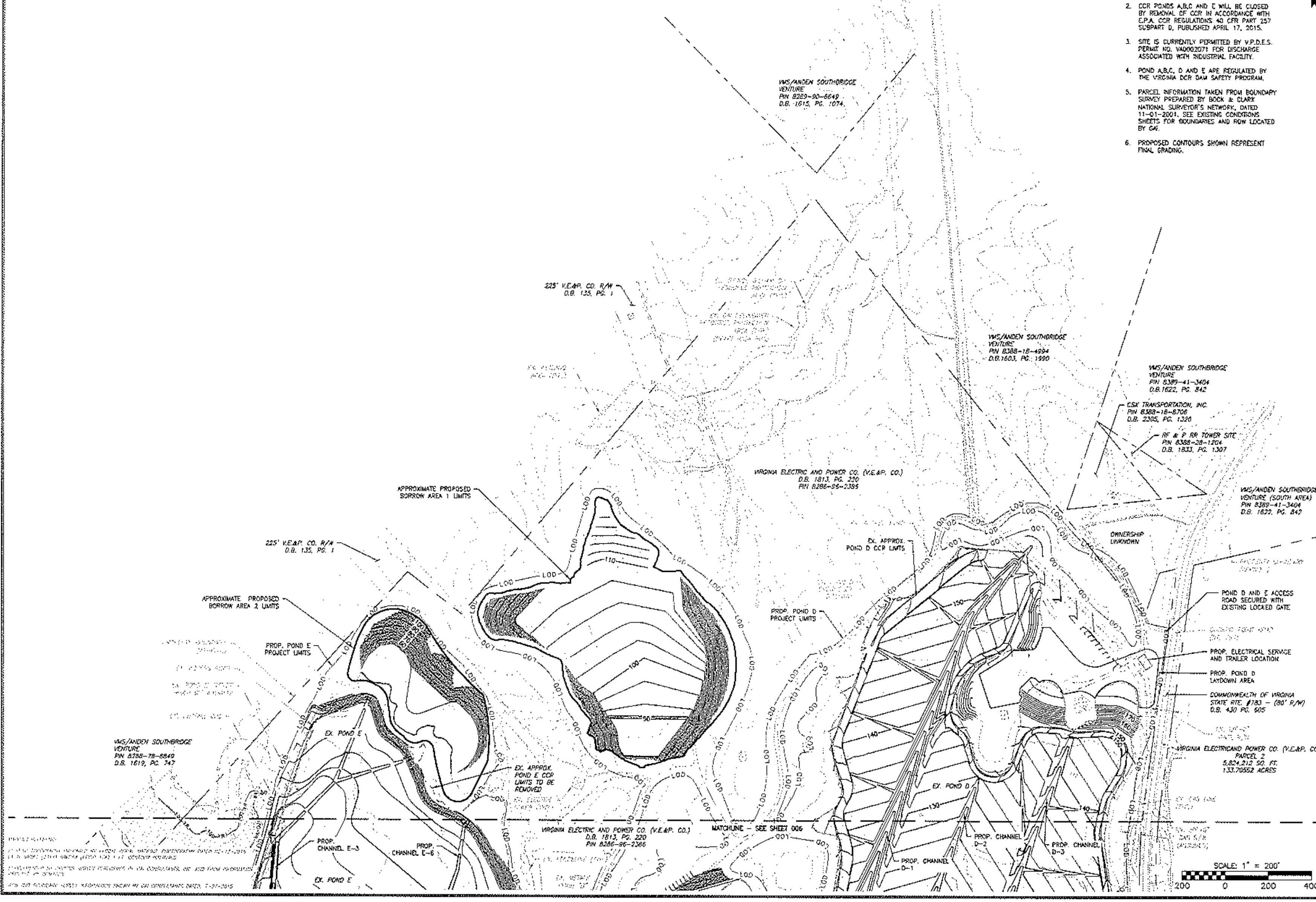
ALT./CLIENT DRAWING NUMBER:

GAI DRAWING NUMBER: 006

PERMIT

NOTES:

1. POND D WILL BE CLOSED IN PLACE WITH A SOIL AND GEOSYNTHETIC CAP IN ACCORDANCE WITH E.P.A. CCR REGULATIONS 40 CFR PART 257 SUBPART D, PUBLISHED APRIL 17, 2015.
2. CCR PONDS A,B,C AND E WILL BE CLOSED BY REMOVAL OF CCR IN ACCORDANCE WITH E.P.A. CCR REGULATIONS 40 CFR PART 257 SUBPART D, PUBLISHED APRIL 17, 2015.
3. SITE IS CURRENTLY PERMITTED BY V.P.D.E.S. PERMIT NO. VA0002071 FOR DISCHARGE ASSOCIATED WITH INDUSTRIAL FACILITY.
4. POND A,B,C, D AND E ARE REGULATED BY THE VIRGINIA DCR DAM SAFETY PROGRAM.
5. PARCEL INFORMATION TAKEN FROM BOUNDARY SURVEY PREPARED BY BOCK & CLARK NATIONAL SURVEYOR'S NETWORK, DATED 11-01-2001. SEE EXISTING CONDITIONS SHEETS FOR BOUNDARIES AND ROW LOCATED BY GAI.
6. PROPOSED CONTOURS SHOWN REPRESENT FINAL GRADING.



DRAWING TITLE	SITE MASTER/ACCESS PLAN (2 OF 2)
PROJECT	POSSUM POINT POWER STATION COAL COMBUSTION RESIDUAL SURFACE IMPOUNDMENT CLOSURES DUMFRIES, VA
	gai consultants
CLIENT	VIRGINIA ELECTRIC AND POWER COMPANY GLEN ALLEN, VA

ISSUING OFFICE: Richmond | 4198 Cox Road, Suite 114, Glen Allen, VA 23060

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REVISION RECORD

JOHN R. KLAMUT Lic. No. [illegible] 11/12/2015

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DWG TYPE:	SCALE:	ISSUE DATE:
	AS SHOWN	11/18/2015

SHEET NO.: 7 OF 65

REVISION: △

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ALT./CLIENT DRAWING NUMBER:

GAI DRAWING NUMBER: 007

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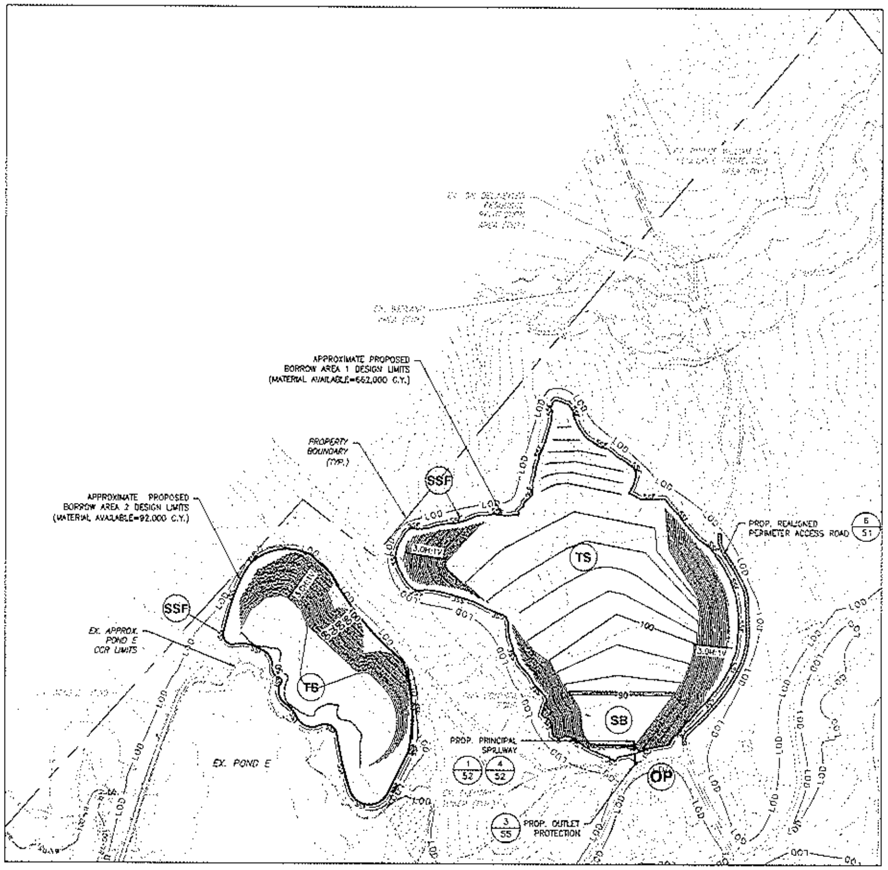
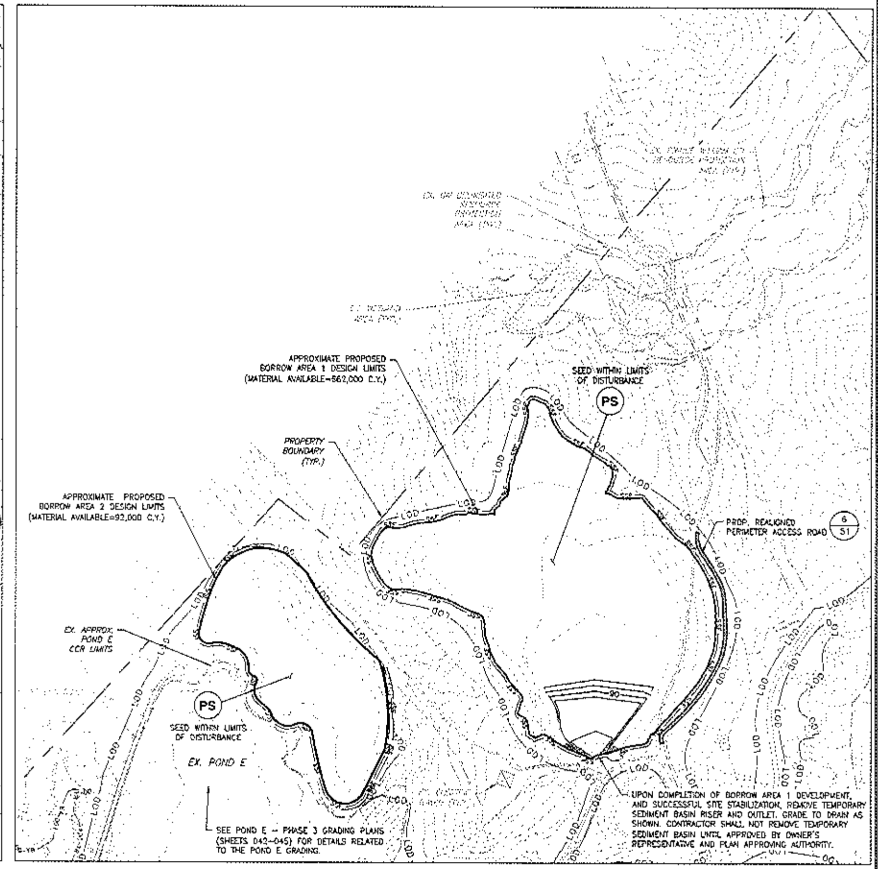


PHASE 1



PHASE 2

BORROW AREA	APPROX. MATERIAL AVAILABLE
1	662,000 C.Y.
2	92,000 C.Y.

PHASE 1 PLAN NOTE:

1. CONTRACTOR SHALL STRIP TOP SOIL (TOP 6" MIN.) AND STOCKPILE FOR USE AS VEGETATIVE SUPPORT LAYER IN POND D FINAL COVER.

GENERAL SOIL BORROW DEVELOPMENT PLAN NOTES:

1. ESTIMATED SOIL VOLUMES ARE APPROXIMATE BASED ON SOILS INFORMATION OBTAINED FROM THE SOIL BORINGS AND EXCAVATED TEST PITS.
2. FINAL GRADING SHOWN FOR BORROW AREA 1 YIELDS 662,000 C.Y. OF SOIL.
3. MAXIMUM SLOPE IS 3H:1V. GRADE TO DRAIN MINIMUM SLOPE IS 1%.

PHASE 2 PLAN NOTE:

1. MAXIMUM LIMITS OF PROPOSED BORROW AREAS SHOWN. CONTRACTOR MAY REDUCE BORROW AREA L.O.D. AND MODIFY GRADING PER NOTE 3, AS APPROVED BY THE OWNER'S ENGINEER.

SCALE: 1" = 200'

DRAWING TITLE: SOIL BORROW AREA DEVELOPMENT PLAN

PROJECT: POSSUM POINT POWER STATION COAL COMBUSTION RESIDUAL SURFACE IMPOUNDMENT CLOSURES DUMFRIES, VA

CLIENT: VIRGINIA ELECTRIC AND POWER COMPANY GLEN ALLEN, VA

gai consultants

ISSUING OFFICE: Richmond

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REVISION RECORD

JOHN R. ELMET Lic. No. 25559 11/18/2015

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SHEET NO.: 8 OF 65

REVISION

GAI FILE NUMBER: C150132-00-000-C-D1-008

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GAI DRAWING NUMBER: 008

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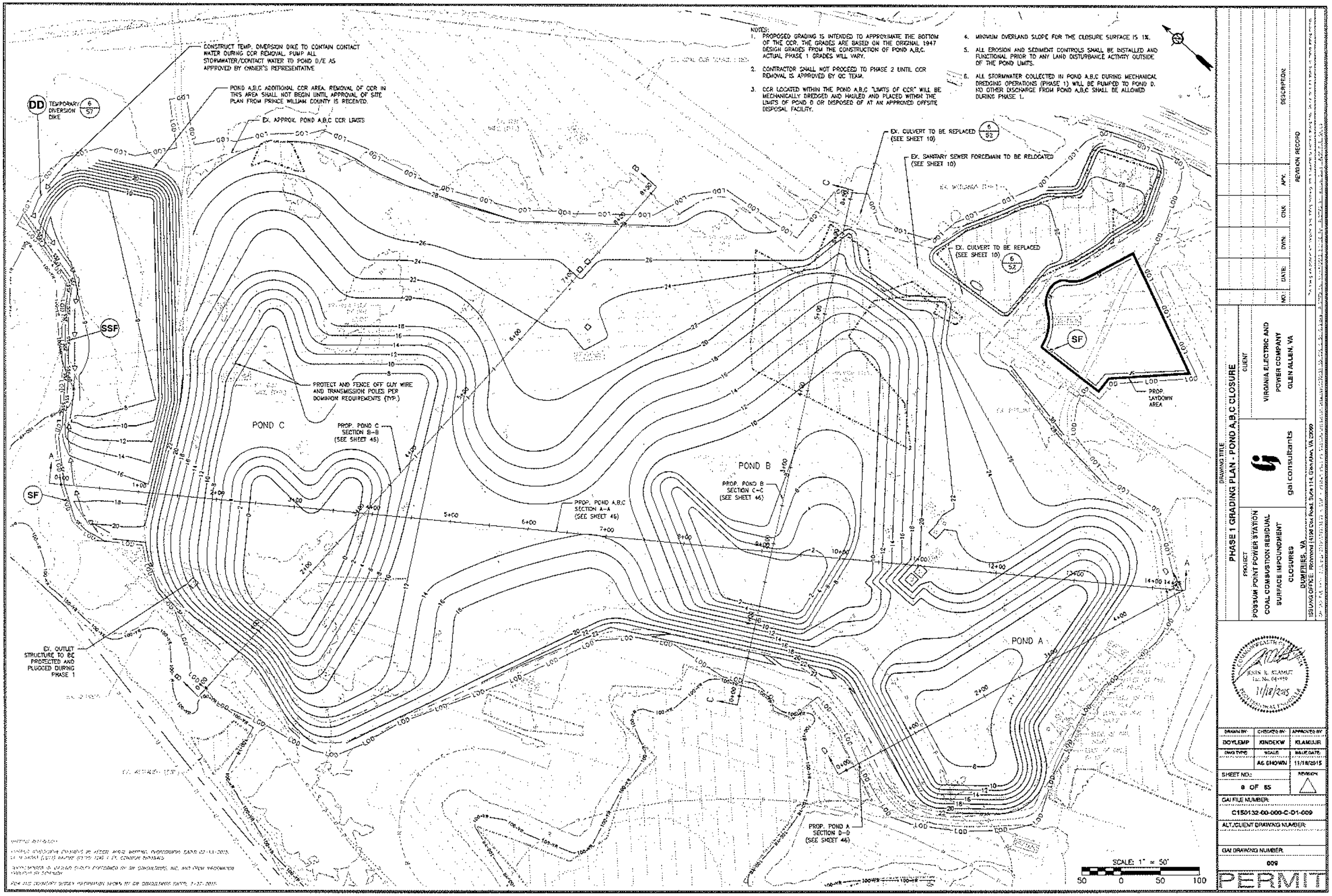
NOTES:
1. PROPOSED GRADING IS INTENDED TO APPROXIMATE THE BOTTOM OF THE CCR. THE GRADES ARE BASED ON THE ORIGINAL 1947 DESIGN GRADES FROM THE CONSTRUCTION OF POND A,B,C. ACTUAL PHASE 1 GRADES WILL VARY.
2. CONTRACTOR SHALL NOT PROCEED TO PHASE 2 UNTIL CCR REMOVAL IS APPROVED BY QC TEAM.
3. CCR LOCATED WITHIN THE POND A,B,C "LIMITS OF CCR" WILL BE MECHANICALLY DREDGED AND HAULED AND PLACED WITHIN THE LIMITS OF POND D OR DISPOSED OF AT AN APPROVED OFFSITE DISPOSAL FACILITY.
4. MINIMUM OVERLAND SLOPE FOR THE CLOSURE SURFACE IS 1%.
5. ALL EROSION AND SEDIMENT CONTROLS SHALL BE INSTALLED AND FUNCTIONAL PRIOR TO ANY LAND DISTURBANCE ACTIVITY OUTSIDE OF THE POND LIMITS.
6. ALL STORMWATER COLLECTED IN POND A,B,C DURING MECHANICAL DREDGING OPERATIONS (PHASE 1) WILL BE PUMPED TO POND D. NO OTHER DISCHARGE FROM POND A,B,C SHALL BE ALLOWED DURING PHASE 1.
CONSTRUCT TEMP. DIVERSION DIKE TO CONTAIN CONTACT WATER DURING CCR REMOVAL. PUMP ALL STORMWATER/CONTACT WATER TO POND D/E AS APPROVED BY OWNER'S REPRESENTATIVE
POND A,B,C ADDITIONAL CCR AREA. REMOVAL OF CCR IN THIS AREA SHALL NOT BEGIN UNTIL APPROVAL OF SITE PLAN FROM PRINCE WILLIAM COUNTY IS RECEIVED.
EX. APPROX. POND A,B,C CCR LIMITS
TEMPORARY DIVERSION DIKE
EX. CULVERT TO BE REPLACED (SEE SHEET 10)
EX. SANITARY SEWER FORCEMAIN TO BE RELOCATED (SEE SHEET 10)
PROP. LAYDOWN AREA
PROTECT AND FENCE OFF GUY WIRE AND TRANSMISSION POLES PER DOMINION REQUIREMENTS (TYP.)
POND C
PROP. POND C SECTION B-B (SEE SHEET 46)
POND B
PROP. POND B SECTION C-C (SEE SHEET 46)
PROP. POND A,B,C SECTION A-A (SEE SHEET 46)
POND A
PROP. POND A SECTION D-D (SEE SHEET 46)
EX. OUTLET STRUCTURE TO BE PROTECTED AND PLUGGED DURING PHASE 1
SCALE: 1" = 50'
DRAWING TITLE
PHASE 1 GRADING PLAN - POND A,B,C CLOSURE
PROJECT
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA
gai consultants
CLIENT
VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA
REVISION RECORD
NO. DATE DWN. CHK. APV. DESCRIPTION
DRAWN BY: DOYLEMP
CHECKED BY: KINDEKW
APPROVED BY: KLAMUJR
SCALE: AS SHOWN
ISSUE DATE: 11/18/2015
SHEET NO.: 9 OF 85
GAI FILE NUMBER: C150132-00-000-C-D1-009
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GAI DRAWING NUMBER: 009
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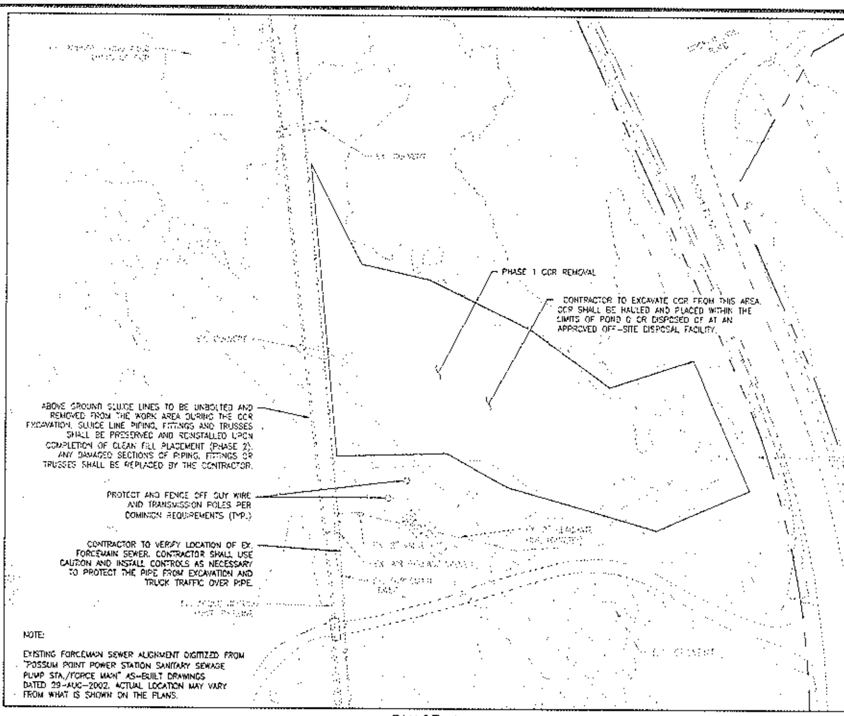
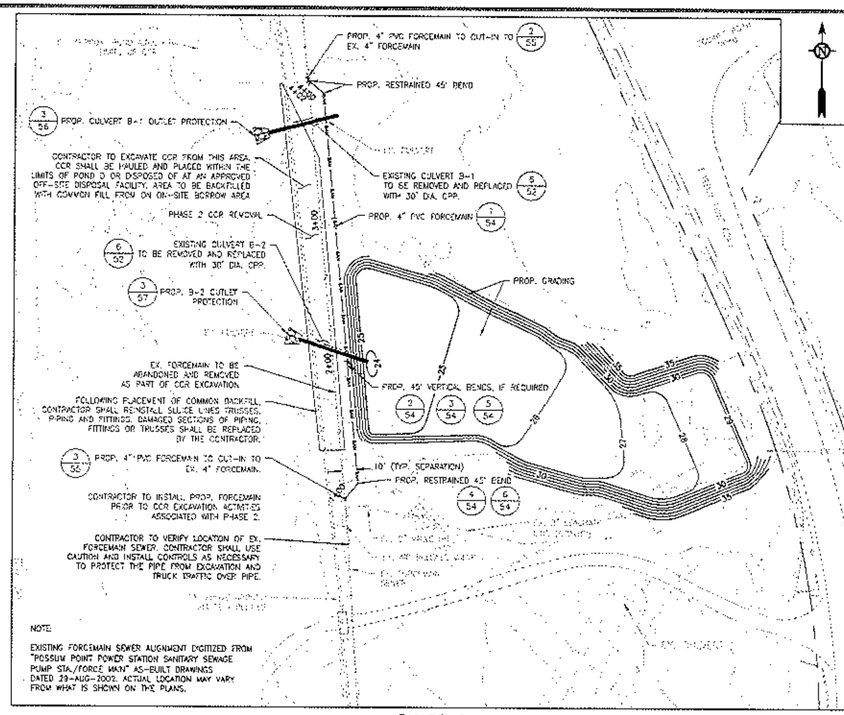


PHASE 1



PHASE 2

SANITARY SEWER FORCEMAIN RELOCATION GENERAL NOTES:

A. PRIOR TO COMMENCING WORK ACTIVITIES:

1. APPROVED EROSION AND SEDIMENT CONTROLS ARE TO BE INSTALLED AND MAINTAINED IN ACCORDANCE WITH THE PLANS AND SPECIFICATIONS.
2. CONTRACTOR SHALL FIELD LOCATE ALL UNDERGROUND UTILITIES IN ADVANCE OF CONSTRUCTION AND TAKE MEASURES TO PROTECT THEM FROM DAMAGE DURING CONSTRUCTION.
3. CONTRACTOR SHALL STAKE OUT ALL UTILITIES AND LIMITS OF WORK AREAS.
4. PROVIDE THE OWNER WITH A PLANNED CONSTRUCTION SCHEDULE/SEQUENCE AND TESTING PLAN FOR APPROVAL.
5. CONTRACTOR SHALL FIELD VERIFY THE FORCEMAIN SIZE AND MATERIAL AT THE TIE-IN POINTS PRIOR TO ORDERING PIPING, FITTINGS, COUPLINGS AND JOINT RESTRAINTS. IN THE EVENT AN UNEXPECTED PIPE SIZE OR MATERIAL IS IDENTIFIED, NOTIFY THE OWNER AND ENGINEER IMMEDIATELY.

B. PRIOR TO PERFORMING THE CUT-INS TO THE EXISTING FORCEMAIN:

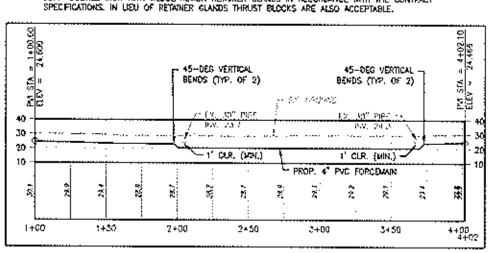
1. NOTIFY THE STATION AT LEAST TWO WEEKS IN ADVANCE OF INTENT TO PERFORM THE CUT-INS AND TO COORDINATE THE TIME OF THE REQUIRED SHUTDOWN.
2. VERIFY THAT THE OWNER'S SANITARY SEWAGE TRANSFER PUMPS HAVE BEEN DE-ENERGIZED AND LOCK-OUT/TAG-OUT ("LOTO") PROCEDURES HAVE BEEN IMPLEMENTED.
3. INSTALL VALVE CUT-IN TO ISOLATE DOWNSTREAM USERS DURING FORCEMAIN RELOCATION WORK. SEE "PROPOSED VALVE CUT-IN LOCATION PLAN", THIS SHEET.
4. THE SECTION OF FORCEMAIN AFFECTED BY THE TIE-INS SHALL BE PUMPED DRY TO A TANKER TRUCK OR OTHER APPROVED LOCATION AND DISPOSED AS ACCEPTABLE TO THE OWNER AND JURISDICTIONAL AGENCY. THIS SHALL BE ACCOMPLISHED USING A WATERTIGHT TAPPING SLEEVE AND VALVE ON A SECTION OF PIPE THAT IS TO BE ABANDONED, AND INSTALLING WATERTIGHT PIPING TO THE PUMP AND TANKER TRUCK OR OTHER APPROVED LOCATION.

C. FORCEMAIN INSTALLATION:

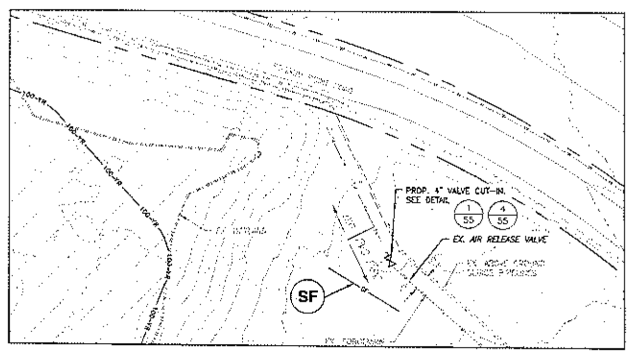
1. ALL BENDS/FITTINGS SHALL INCLUDE THRUST BLOCKING OR RESTRAINTS AT EACH PIPE AND FITTING JOINT AS REQUIRED IN THE THRUST BLOCK DETAILS AND RESTRAINED JOINT SCHEDULES. HOWEVER, RESTRAINTS AT EXISTING FORCEMAIN PIPE AND FITTING JOINTS (THAT ARE TO REMAIN AFTER PIPE ABANDONMENT) ARE REQUIRED PER THE RESTRAINED JOINT SCHEDULES TO BRACE THE FORCEMAIN DURING REMOVAL OF THE SECTION TO BE ABANDONED.
2. THE CONTRACTOR SHALL PERFORM AN APPROVED HYDROSTATIC PRESSURE TEST ON THE NEWLY INSTALLED FORCEMAIN IN ACCORDANCE WITH THE CONTRACT SPECIFICATIONS.
3. THE CONTRACTOR SHALL CORRECT ANY LEAKS IN THE NEWLY INSTALLED FORCEMAIN AND RE-TEST, AS NECESSARY, UNTIL AN ACCEPTABLE HYDROSTATIC PRESSURE TEST RESULT IS ATTAINED.
4. UPON COMPLETION OF AN ACCEPTABLE HYDROSTATIC PRESSURE TEST, THE CONTRACTOR SHALL COORDINATE WITH THE OWNER TO RETURN THE SANITARY FORCEMAIN SYSTEM INTO OPERATION AND REMOVE ALL "LOTO" DEVICES.
5. THE CONTRACTOR SHALL PLAN AND MAKE EVERY EFFORT TO COMPLETE THE FORCEMAIN TIE-INS AND MINIMIZE DOWNTIME TO 4 HOURS OR AS OTHERWISE AGREED IN ADVANCE WITH THE OWNER.
6. DETAILS ASSOCIATED WITH THE SANITARY SEWER FORCEMAIN RELOCATION ARE SHOWN ON SHEETS 53 AND 54.

D. FORCEMAIN MATERIALS:

1. PIPE SHALL BE GASKETED, PUSH-ON JOINT PVC PRESSURE PIPE IN ACCORDANCE WITH THE CONTRACT SPECIFICATIONS.
2. FITTINGS SHALL BE GASKETED, PUSH-ON JOINT PVC WITH RESTRAINT HARNESSES OR MECHANICAL JOINT DUCTILE IRON WITH WEDGE ACTION RETAINER GLANDS IN ACCORDANCE WITH THE CONTRACT SPECIFICATIONS. IN LIEU OF RETAINER GLANDS THRUST BLOCKS ARE ALSO ACCEPTABLE.



PROPOSED RELOCATED FORCEMAIN SEWERLINE PROFILE



NOTES:

1. LOCATION OF FORCEMAIN APPROXIMATED FROM AS-BUILT DRAWING FOR "POSSUM POINT POWER STATION SANITARY SEWER PUMP STA./FORCEMAIN". DRAWING NO. 9158A-BC-006, REV 1, DATED 05-SEPT-2002.
2. CONTRACTOR TO VERIFY LOCATION OF EXISTING FORCEMAIN SEWER AND AIR RELEASE VALVE.
3. CONTRACTOR SHALL INSTALL SILT FENCING AND OTHER EROSION AND SEDIMENT CONTROL BMPS AS NECESSARY DOWNGRADIENT OF THE WORK AREA PRIOR TO ANY EARTH DISTURBING ACTIVITIES.
4. PROP. 4" VALVE CUT-IN TO BE LOCATED 15' DOWNSTREAM OF THE EXISTING AIR RELEASE VALVE. LOCATION OF PROPOSED VALVE TO BE APPROVED BY OWNER'S REPRESENTATIVE PRIOR TO INSTALLATION.

PROPOSED VALVE CUT-IN LOCATION PLAN

SCALE: 1" = 40'
40 0 40 80

NO.	DATE	DWN.	CHK.	APP.	DESCRIPTION

REVISION RECORD

DRAWING TITLE: SANITARY SEWER RELOCATION PLAN - POND A,B,C CLOSURE

PROJECT: POSSUM POINT POWER STATION COAL COMBUSTION RESIDUAL SURFACE IMPOUNDMENT CLOSURES DUMFRIES, VA

gai consultants

CLIENT: VIRGINIA ELECTRIC AND POWER COMPANY GLEN ALLEN, VA

ISSUING OFFICE: Richmond | 4198 Cox Road, Suite 114, Glen Allen, VA 23060

JOHN R. KLAMUT Lic. No. 044442 11/18/2015

DRAWN BY:	CHECKED BY:	APPROVED BY:
DOYLEMP	KINDEXW	KLAMUJR
DWG TYPE:	SCALE:	ISSUE DATE:
	AS SHOWN	11/18/2015

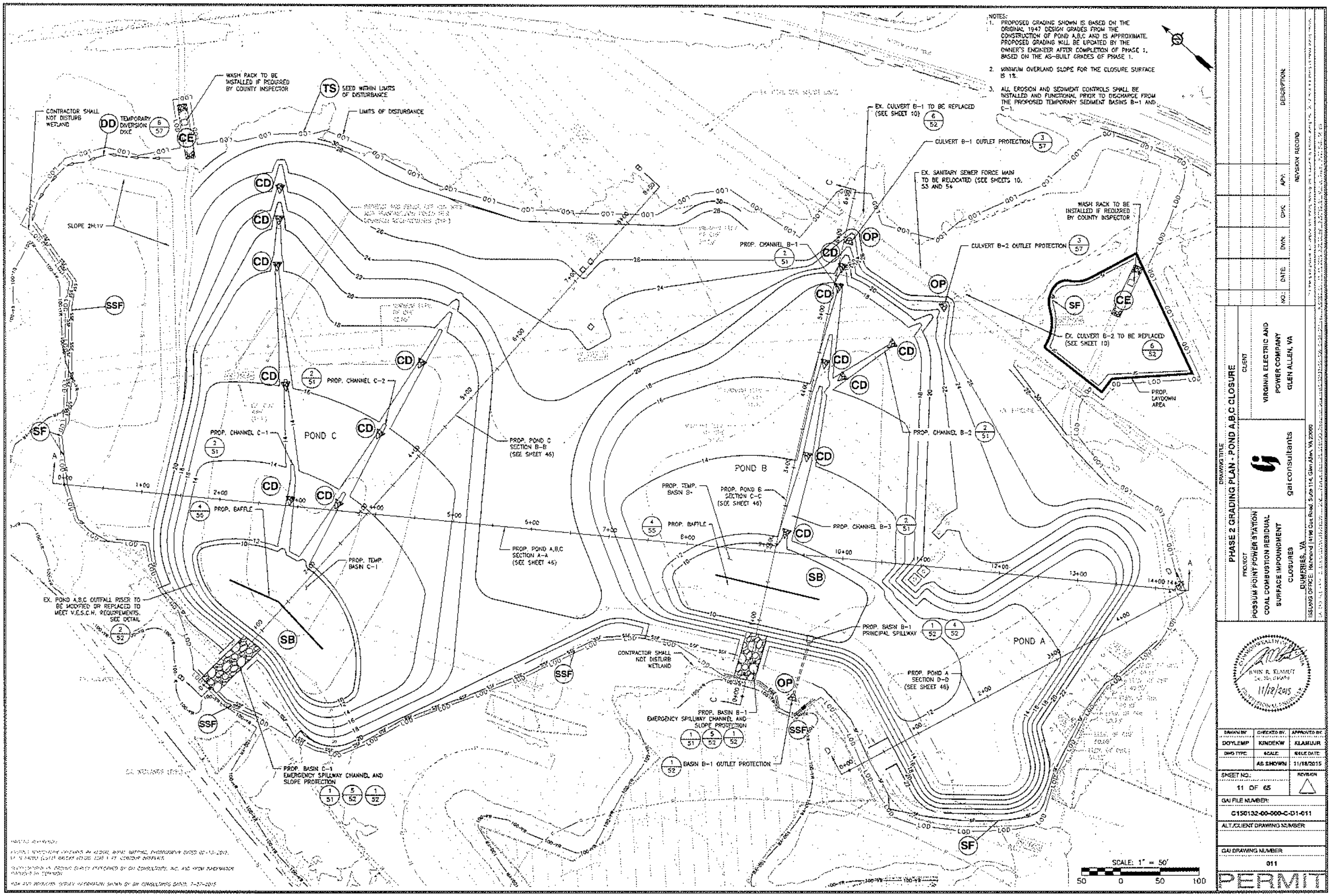
SHEET NO.: 10 OF 65 REVISION

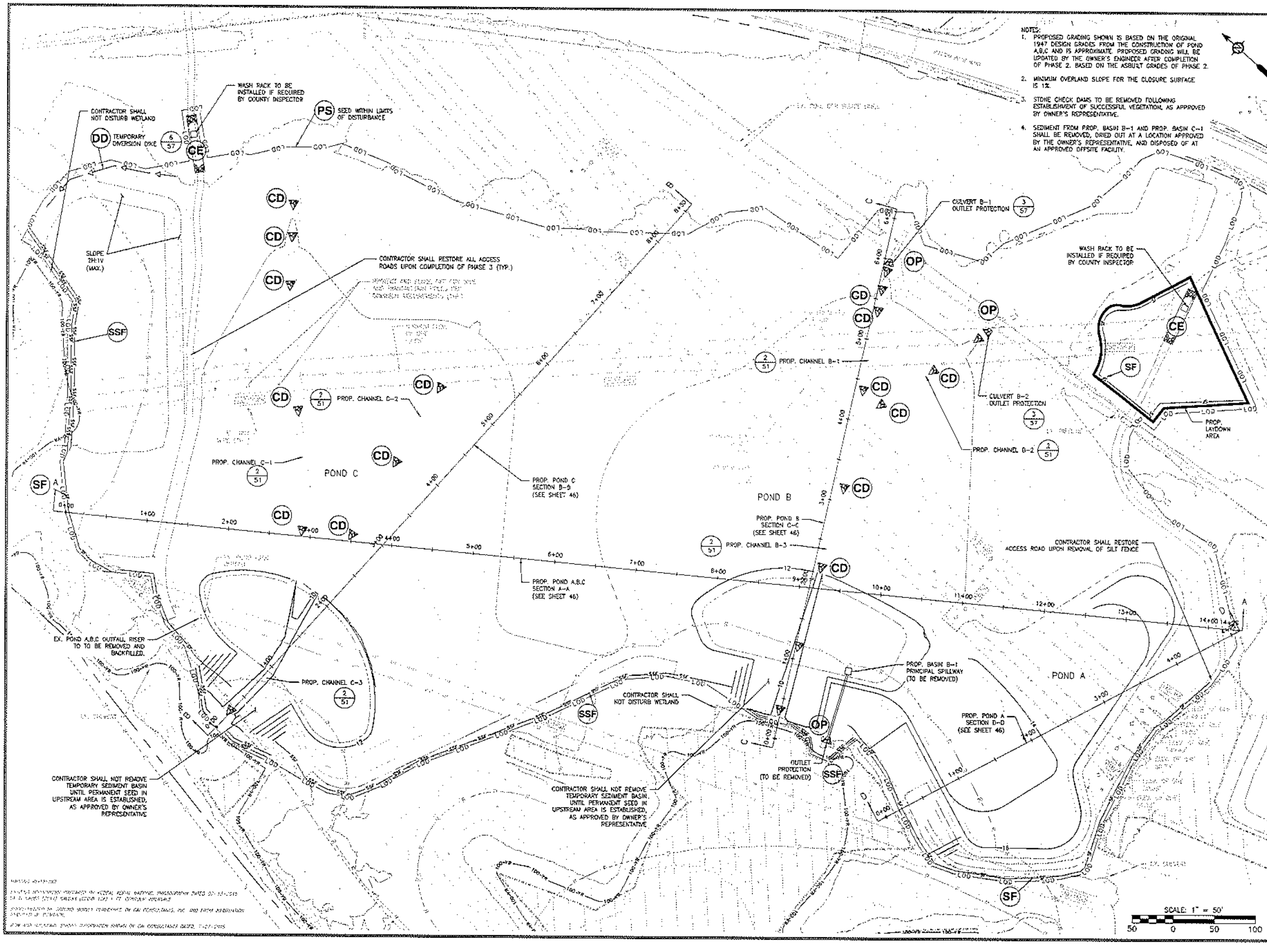
GAI FILE NUMBER: C150132-00-000-C-D1-010

ALT./CLIENT DRAWING NUMBER:

GAI DRAWING NUMBER: 010

PERMIT


NOTES:
1. PROPOSED GRADING SHOWN IS BASED ON THE ORIGINAL 1947 DESIGN GRADES FROM THE CONSTRUCTION OF POND A,B,C AND IS APPROXIMATE. PROPOSED GRADING WILL BE UPDATED BY THE OWNER'S ENGINEER AFTER COMPLETION OF PHASE 1, BASED ON THE AS-BUILT GRADES OF PHASE 1.
2. MINIMUM OVERLAND SLOPE FOR THE CLOSURE SURFACE IS 1%.
3. ALL EROSION AND SEDIMENT CONTROLS SHALL BE INSTALLED AND FUNCTIONAL PRIOR TO DISCHARGE FROM THE PROPOSED TEMPORARY SEDIMENT BASINS B-1 AND C-1.
POND A
POND B
POND C
PROP. POND A,B,C SECTION A-A (SEE SHEET 45)
PROP. POND C SECTION B-B (SEE SHEET 45)
PROP. POND B SECTION C-C (SEE SHEET 46)
PROP. POND A SECTION D-D (SEE SHEET 46)
PROP. BASIN B-1 PRINCIPAL SPILLWAY
PROP. BASIN B-1 EMERGENCY SPILLWAY CHANNEL AND SLOPE PROTECTION
PROP. BASIN C-1 EMERGENCY SPILLWAY CHANNEL AND SLOPE PROTECTION
BASIN B-1 OUTLET PROTECTION
EX. POND A,B,C OUTFALL RISER TO BE MODIFIED OR REPLACED TO MEET V.E.S.C.H. REQUIREMENTS. SEE DETAIL
EX. CULVERT B-1 TO BE REPLACED (SEE SHEET 10)
EX. CULVERT B-2 TO BE REPLACED (SEE SHEET 10)
CULVERT B-1 OUTLET PROTECTION
CULVERT B-2 OUTLET PROTECTION
EX. SANITARY SEWER FORCE MAIN TO BE RELOCATED (SEE SHEETS 10, 53 AND 54
WASH RACK TO BE INSTALLED IF REQUIRED BY COUNTY INSPECTOR
CONTRACTOR SHALL NOT DISTURB WETLAND
TEMPORARY DIVERSION DIKE
SEED WITHIN LIMITS OF DISTURBANCE
LIMITS OF DISTURBANCE
SLOPE 2H:1V
PROP. CHANNEL B-1
PROP. CHANNEL B-2
PROP. CHANNEL B-3
PROP. CHANNEL C-1
PROP. CHANNEL C-2
PROP. TEMP. BASIN B-1
PROP. TEMP. BASIN C-1
PROP. BAFFLE
PROP. LAYDOWN AREA
SCALE: 1" = 50'
DRAWING TITLE
PHASE 2 GRADING PLAN - POND A,B,C CLOSURE
PROJECT
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL SURFACE IMPOUNDMENT CLOSURES
DUMFRIES, VA
gaiconsultants
CLIENT
VIRGINIA ELECTRIC AND POWER COMPANY
GLEN ALLEN, VA
NO. DATE DWN. CHK. APV. DESCRIPTION
REVISION RECORD
DRAWN BY: DOYLEMP
CHECKED BY: KINDEKW
APPROVED BY: KLAMJJR
DWG TYPE:
SCALE: AS SHOWN
ISSUE DATE: 11/18/2015
SHEET NO.: 11 OF 65
GAI FILE NUMBER: C150132-00-000-C-D1-011
ALT./CLIENT DRAWING NUMBER:
GAI DRAWING NUMBER: 011
PERMIT



NOTES:

1. PROPOSED GRADING SHOWN IS BASED ON THE ORIGINAL 1947 DESIGN GRADES FROM THE CONSTRUCTION OF POND A,B,C AND IS APPROXIMATE. PROPOSED GRADING WILL BE UPDATED BY THE OWNER'S ENGINEER AFTER COMPLETION OF PHASE 2. BASED ON THE ASBUILT GRADES OF PHASE 2.
2. MINIMUM OVERLAND SLOPE FOR THE CLOSURE SURFACE IS 1%.
3. STONE CHECK DAMS TO BE REMOVED FOLLOWING ESTABLISHMENT OF SUCCESSFUL VEGETATION, AS APPROVED BY OWNER'S REPRESENTATIVE.
4. SEDIMENT FROM PROP. BASIN B-1 AND PROP. BASIN C-1 SHALL BE REMOVED, DRIED OUT AT A LOCATION APPROVED BY THE OWNER'S REPRESENTATIVE, AND DISPOSED OF AT AN APPROVED OFFSITE FACILITY.

NO.	DATE	DWN	CHK	APV	DESCRIPTION

REVISION RECORD

DRAWING TITLE

PHASE 3 GRADING PLAN - POND A,B,C CLOSURE

CLIENT

VIRGINIA ELECTRIC AND POWER COMPANY
GLEN ALLEN, VA

gai consultants

PROJECT

POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL SURFACE IMPOUNDMENT CLOSURES
DUMFRIES, VA

ISSUING OFFICE: Richmond | 4198 Cox Road, Suite 114, Glen Allen, VA 23060

JOHN R. KLAMUT Lic. No. 24659 11/18/2015

DRAWN BY:	CHECKED BY:	APPROVED BY:
DOYLEMP	KINDEKW	KLAMUJR
DWG TYPE:	SCALE:	ISSUE DATE:
	AS SHOWN	11/18/2015

SHEET NO.: 12 OF 65

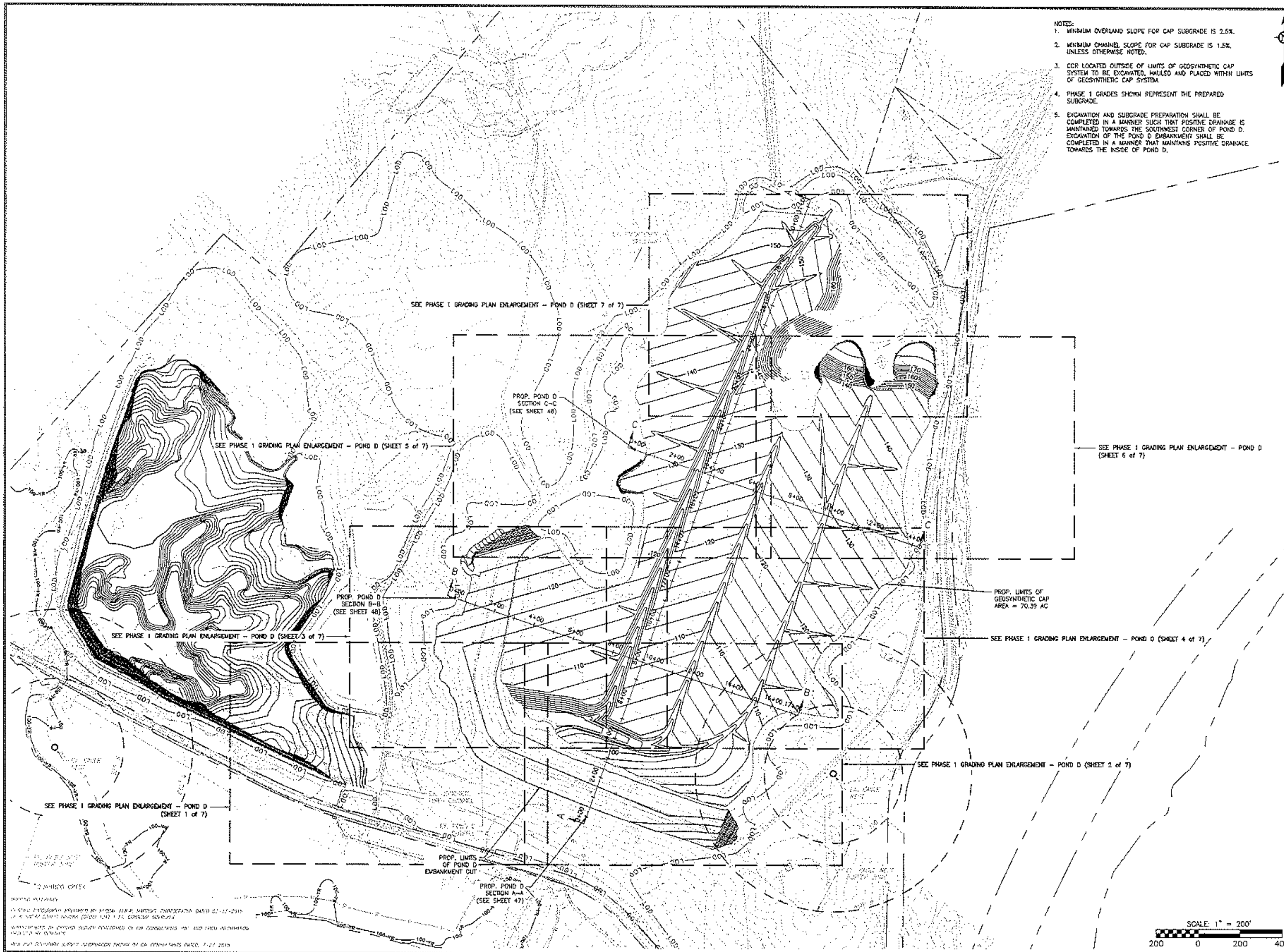
REVISION

GAI FILE NUMBER: C150132-00-000-C-D1-012

ALT./CLIENT DRAWING NUMBER:

GAI DRAWING NUMBER: 012

PERMIT



NOTES:
1. MINIMUM OVERLAND SLOPE FOR CAP SUBGRADE IS 2.5%.
2. MINIMUM CHANNEL SLOPE FOR CAP SUBGRADE IS 1.5%, UNLESS OTHERWISE NOTED.
3. CCR LOCATED OUTSIDE OF LIMITS OF GEOSYNTHETIC CAP SYSTEM TO BE EXCAVATED, HAULED AND PLACED WITHIN LIMITS OF GEOSYNTHETIC CAP SYSTEM.
4. PHASE 1 GRADES SHOWN REPRESENT THE PREPARED SUBGRADE.
5. EXCAVATION AND SUBGRADE PREPARATION SHALL BE COMPLETED IN A MANNER SUCH THAT POSITIVE DRAINAGE IS MAINTAINED TOWARDS THE SOUTHWEST CORNER OF POND D. EXCAVATION OF THE POND D EMBANKMENT SHALL BE COMPLETED IN A MANNER THAT MAINTAINS POSITIVE DRAINAGE TOWARDS THE INSIDE OF POND D.

REVISION RECORD

NO.	DATE	DWN.	CHK.	APV.	DESCRIPTION

DRAWING TITLE: OVERALL PHASE 1 GRADING PLAN - POND D CLOSURE

PROJECT: POSSUM POINT POWER STATION COAL COMBUSTION RESIDUAL SURFACE IMPOUNDMENT CLOSURES DUMFRIES, VA

CLIENT: VIRGINIA ELECTRIC AND POWER COMPANY GLEN ALLEN, VA

gai consultants

JOHN R. KLAMUT 11/18/2015

DRAWN BY:	CHECKED BY:	APPROVED BY:
CUMMIRM	KUZMKMW	KLAMUJR
DWG TYPE:	SCALE: AS SHOWN	ISSUE DATE: 11/18/2015

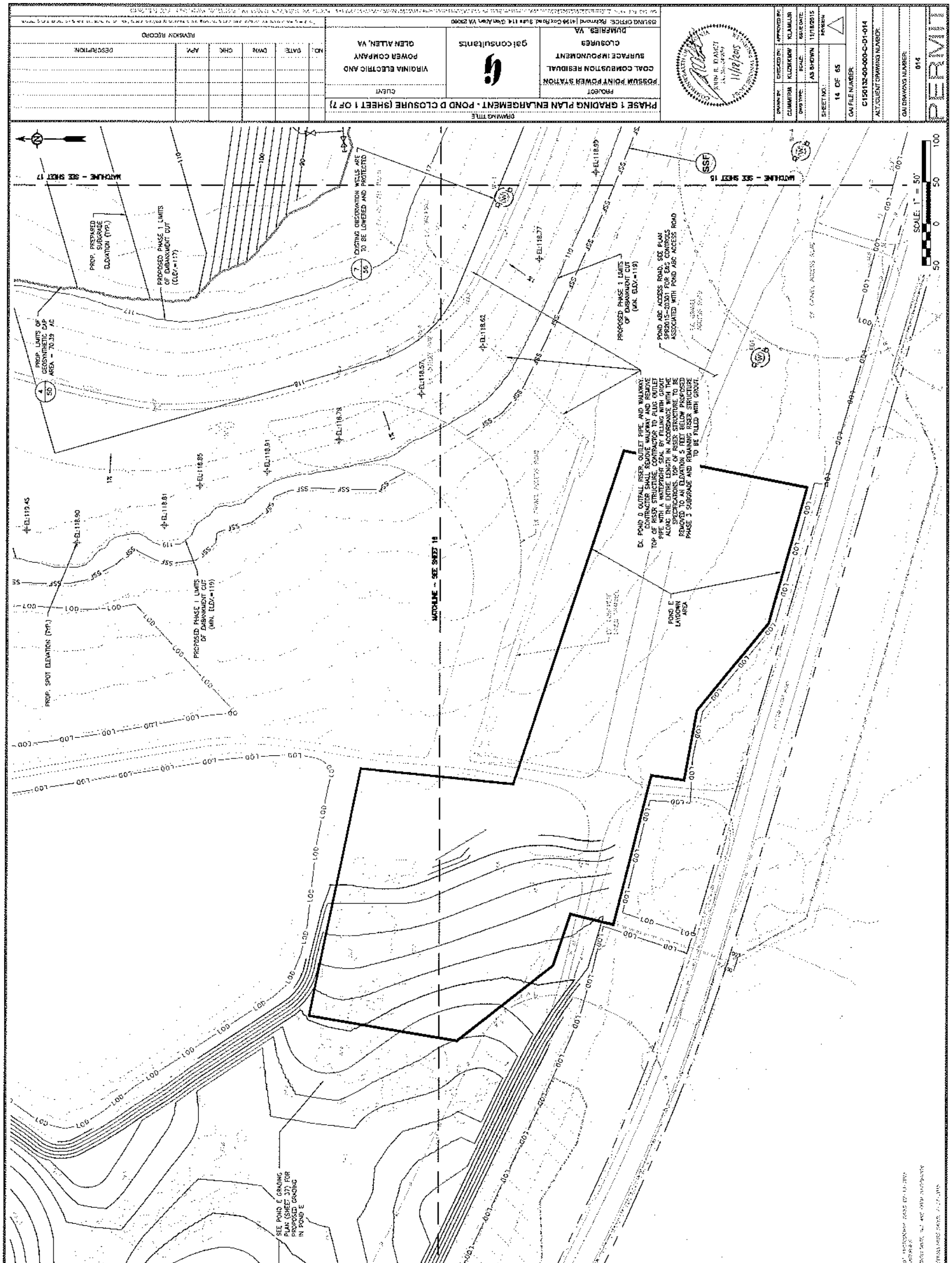
SHEET NO.: 13 OF 65

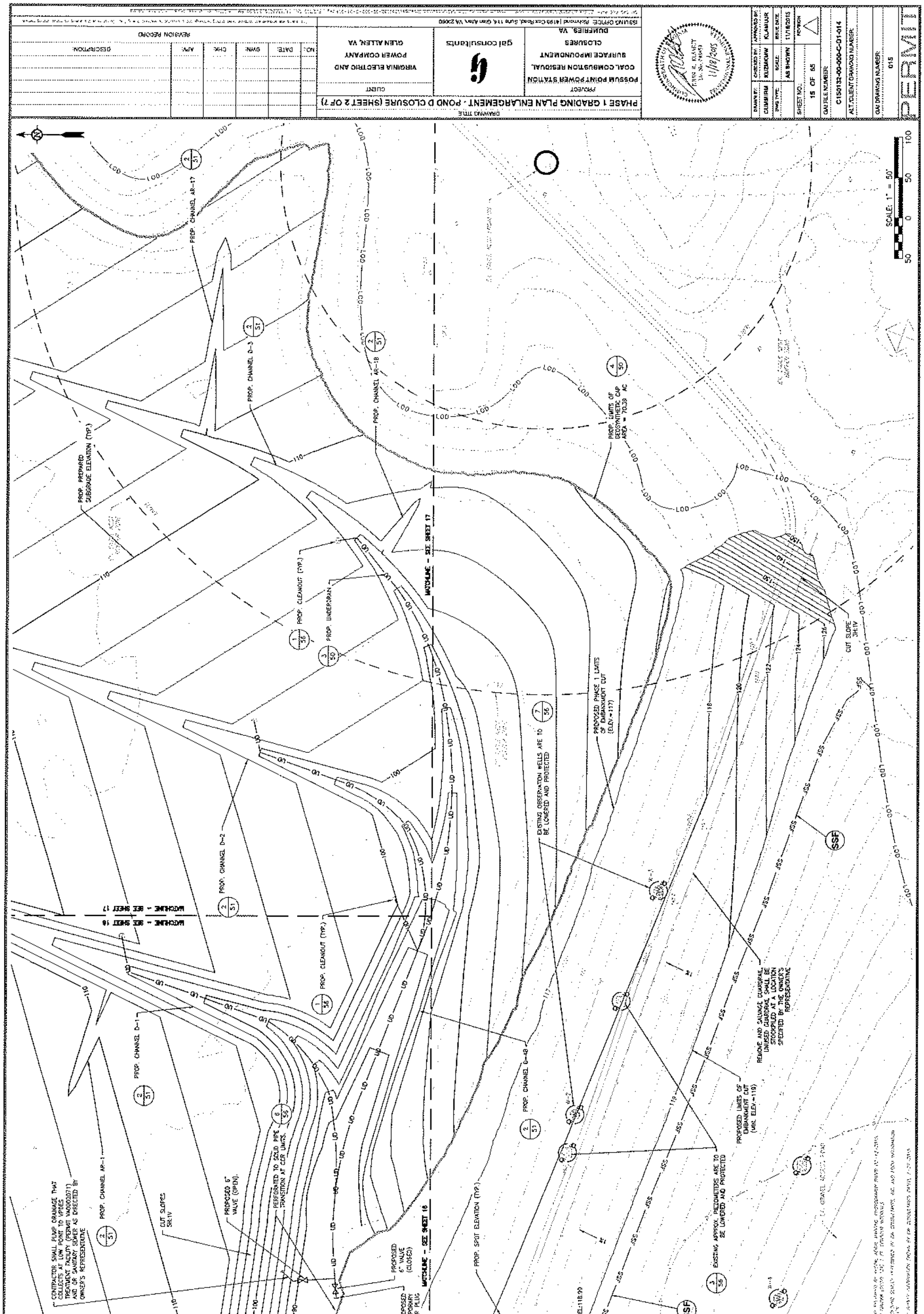
GAI FILE NUMBER: C150132-00-000-C-01-013

ALT./CLIENT DRAWING NUMBER:

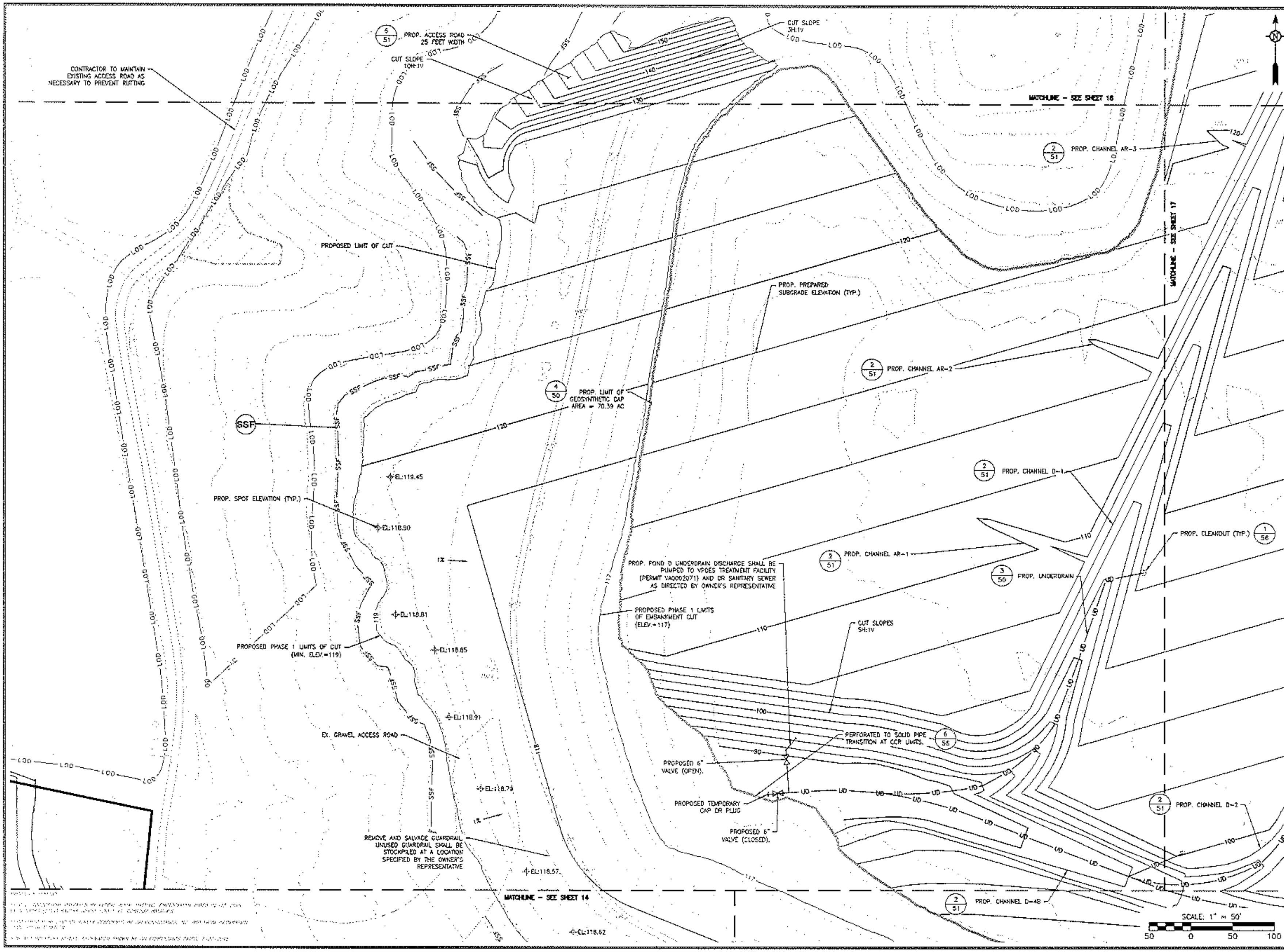
GAI DRAWING NUMBER: 013

PERMIT


PHASE 1 GRADING PLAN ENLARGEMENT - POND D CLOSURE (SHEET 1 OF 7)
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL SURFACE IMPOUNDMENT CLOSURES
DUMFRIES, VA
VIRGINIA ELECTRIC AND POWER COMPANY
GLEN ALLEN, VA
gaiconsultants
REVISION RECORD
14 OF 65
C150132-00-000-C-01-014
PERMIT
MATCHLINE - SEE SHEET 17
MATCHLINE - SEE SHEET 15
MATCHLINE - SEE SHEET 16
POND E LAYDOWN AREA
PROP. SPOT ELEVATION (TYP.)
SCALE: 1" = 50'



PHASE 1 GRADING PLAN ENLARGEMENT - POND D CLOSURE (SHEET 2 OF 7)
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA
gai consultants
VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA
REVISION RECORD
15 OF 65
C150132-00-000-C-01-014
AS SHOWN
11/18/2015
SCALE: 1" = 50'
PROP. CHANNEL AR-17
PROP. CHANNEL D-3
PROP. CHANNEL AR-18
PROP. PREPARED SUBGRADE ELEVATION (TYP.)
PROP. CLEANOUT (TYP.)
PROP. UNDERDRAIN
PROP. CHANNEL D-2
PROP. CHANNEL D-1
PROP. CHANNEL AR-1
PROP. CHANNEL D-4B
CUT SLOPES 3H:1V
CUT SLOPE 3H:1V
PROPOSED 6" VALVE (OPEN)
PROPOSED 6" VALVE (CLOSED)
PERFORATED TO SOLID PIPE TRANSITION AT CCR LIMITS
PROPOSED TEMPORARY CAP OR PLUG
PROP. SPOT ELEVATION (TYP.)
EXISTING OBSERVATION WELLS ARE TO BE LOWERED AND PROTECTED
EXISTING APPROX. PIEZOMETERS ARE TO BE LOWERED AND PROTECTED
PROPOSED PHASE 1 LIMITS OF EMBANKMENT CUT (ELEV.=117)
PROPOSED LIMITS OF EMBANKMENT CUT (MIN. ELEV.=118)
PROP. LIMITS OF GEOSYNTHETIC CAP AREA = 70.39 AC
REMOVE AND SALVAGE GUARDRAIL. UNUSED GUARDRAIL SHALL BE STOCKPILED AT A LOCATION SPECIFIED BY THE OWNER'S REPRESENTATIVE
CONTRACTOR SHALL PUMP DRAINAGE THAT COLLECTS AT LOW POINT TO VPDES TREATMENT FACILITY (PERMIT VA0002071) AND OR SANITARY SEWER AS DIRECTED BY OWNER'S REPRESENTATIVE
MATCHLINE - SEE SHEET 17
MATCHLINE - SEE SHEET 16
MATCHLINE - SEE SHEET 14
PERMIT



DRAWING TITLE
PHASE 1 GRADING PLAN ENLARGEMENT - POND D CLOSURE (SHEET 3 OF 7)

PROJECT
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA

gai consultants

CLIENT
VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA

NO:	DATE:	DWN:	CHK:	APV:	DESCRIPTION:

REVISION RECORD

JOHN R. KLAHUT
11/18/2015

DRAWN BY:	CHECKED BY:	APPROVED BY:
CUM/MRM	KUZ/MKW	KLAM/JJR
DWG TYPE:	SCALE:	ISSUE DATE:
	AS SHOWN	11/18/2015

SHEET NO.: 16 OF 65
REVISION

GAI FILE NUMBER:
C150132-00-000-C-D1-014

ALT./CLIENT DRAWING NUMBER:

GAI DRAWING NUMBER:
016

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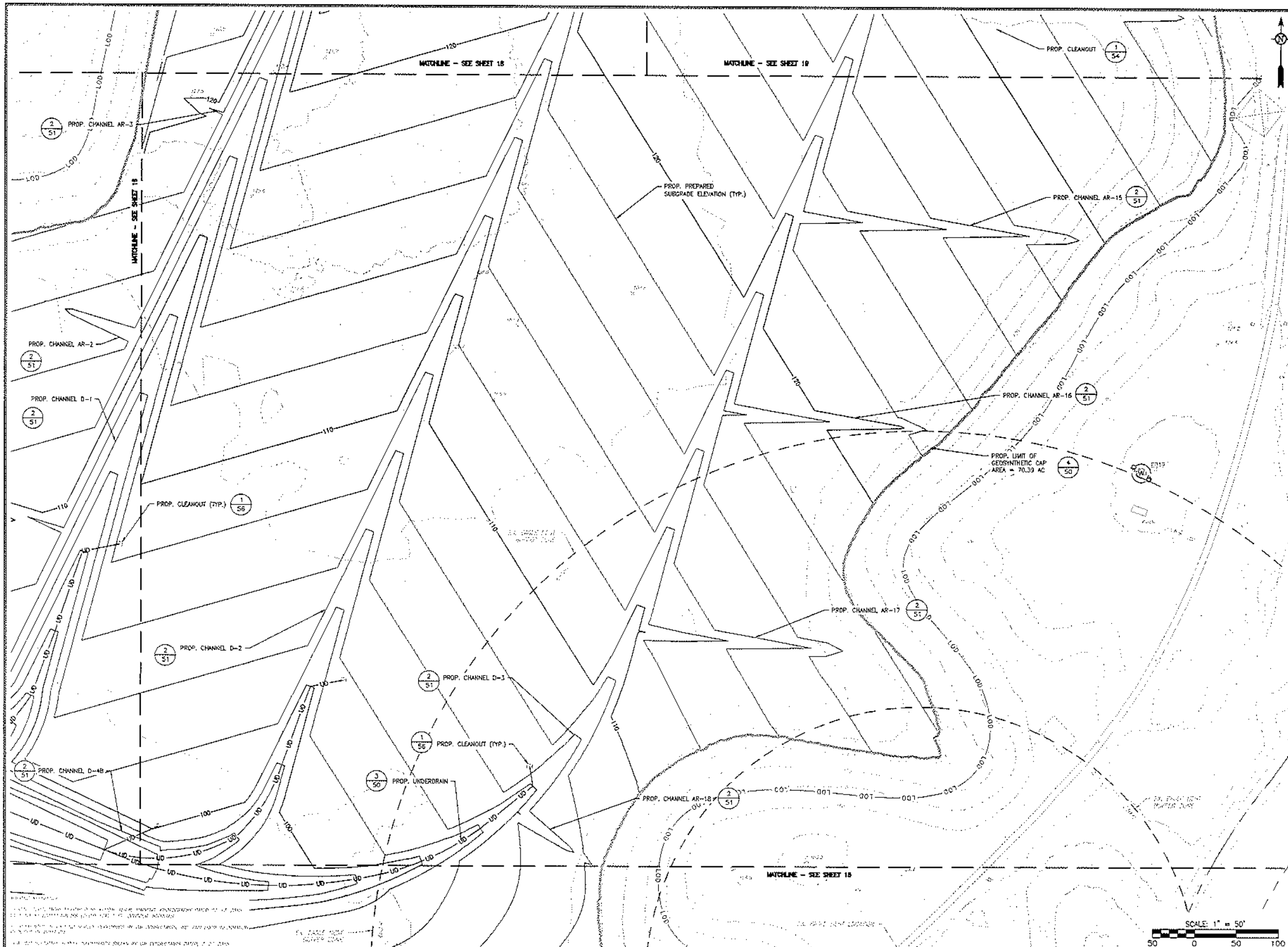


NO.	DATE	DWN.	CHK.	APV.	DESCRIPTION

REVISION RECORD

DRAWING TITLE
PHASE 1 GRADING PLAN ENLARGEMENT - POND D CLOSURE (SHEET 4 OF 7)

PROJECT
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA

gai consultants

CLIENT
VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA

ISSUING OFFICE: Richmond | 4198 Cox Road, Suite 114, Glen Allen, VA 23060

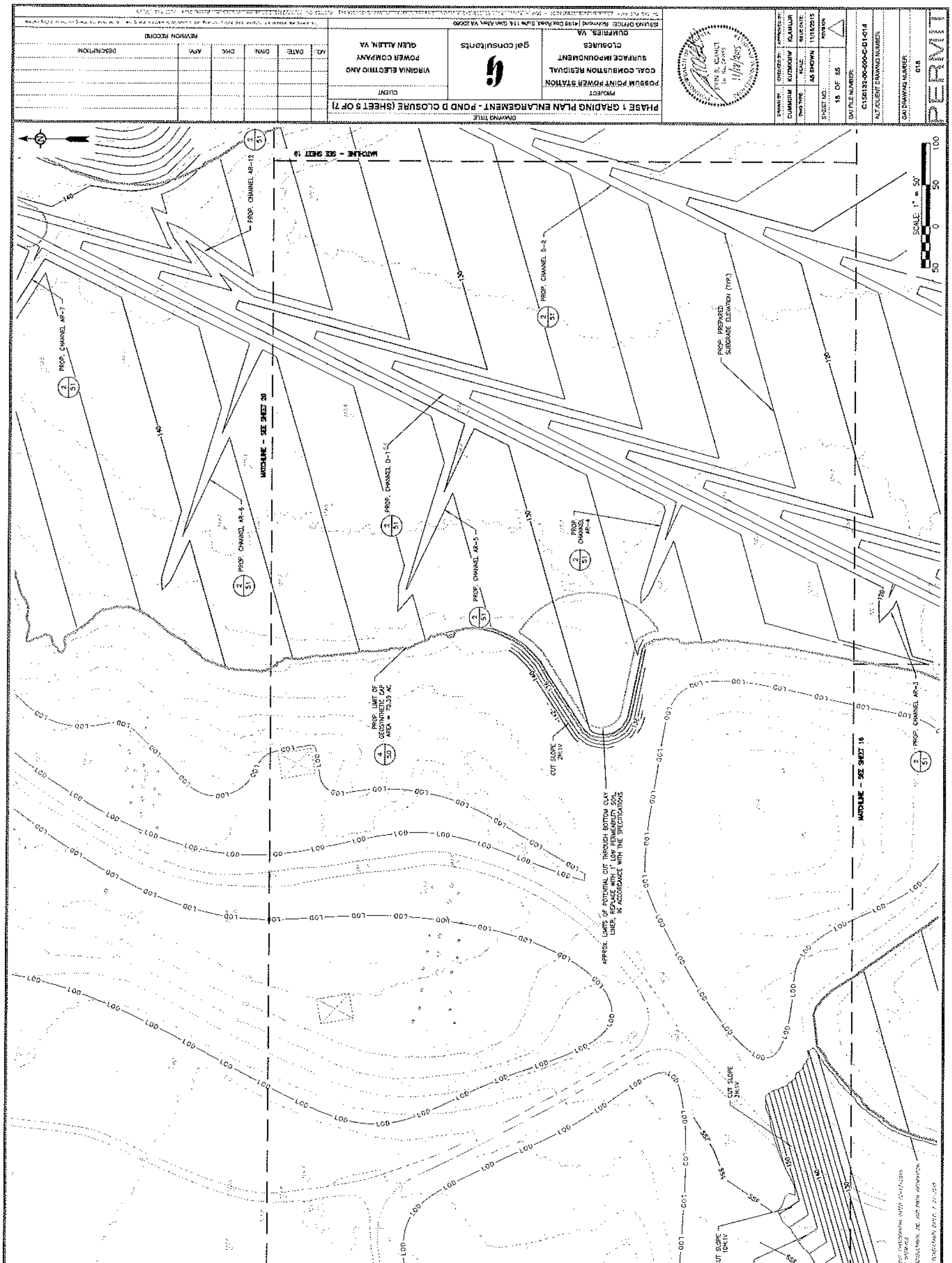
JOHN R. KLAMUT
11/18/2015

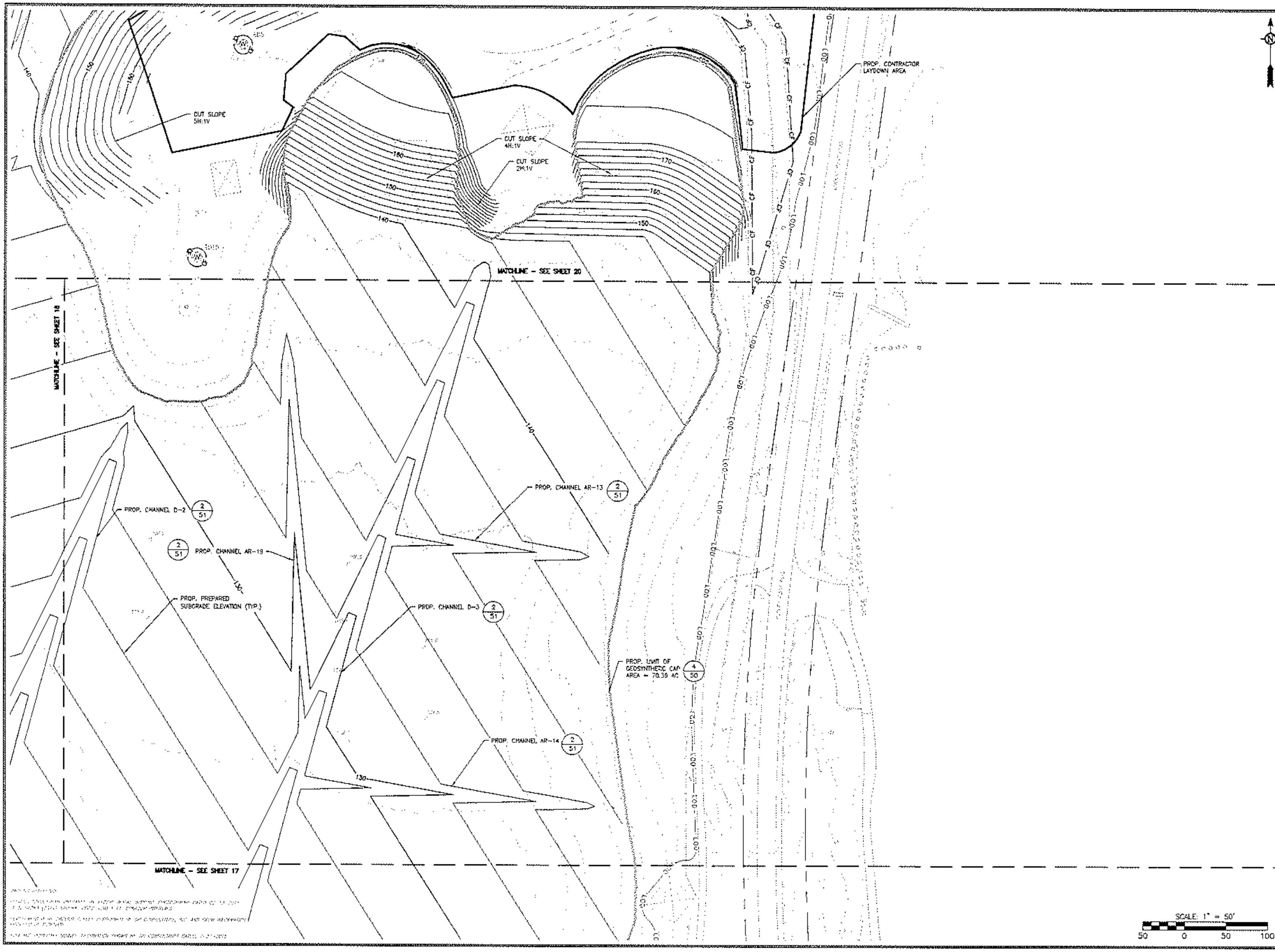
DRAWN BY:	CHECKED BY:	APPROVED BY:
CUMMIRM	KUZMKMW	KLAMUJR
DWG TYPE:	SCALE:	ISSUE DATE:
	AS SHOWN	11/18/2015

SHEET NO.: 17 OF 65
REVISION

GAI FILE NUMBER: C150132-00-000-C-D1-014
ALT./CLIENT DRAWING NUMBER:
GAI DRAWING NUMBER: 017

PERMIT


PHASE 1 GRADING PLAN ENLARGEMENT - POND D CLOSURE (SHEET 5 OF 7)
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL SURFACE IMPOUNDMENT CLOSURES
DUMFRIES, VA
VIRGINIA ELECTRIC AND POWER COMPANY
GLEN ALLEN, VA
gai consultants
PERMIT
MATCHLINE - SEE SHEET 20
MATCHLINE - SEE SHEET 19
MATCHLINE - SEE SHEET 16
PROP. CHANNEL AR-12
PROP. CHANNEL AR-7
PROP. CHANNEL AR-6
PROP. CHANNEL D-1
PROP. CHANNEL AR-5
PROP. CHANNEL AR-4
PROP. CHANNEL D-2
PROP. CHANNEL AR-3
PROP. PREPARED SUBGRADE ELEVATION (TYP.)
CUT SLOPE 2H:1V
CUT SLOPE 10H:1V
PROP. ACCESS ROAD 25 FEET WIDTH
PROPOSED LIMIT OF EMBANKMENT CUT



DRAWING TITLE:
PHASE 1 GRADING PLAN ENLARGEMENT - POND D CLOSURE (SHEET 6 OF 7)

PROJECT
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA

gai consultants

CLIENT
VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA

ISSUING OFFICE: Richmond | 4198 Cox Road, Suite 114, Glen Allen, VA 23060

REVISION RECORD

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DRAWN BY:	CHECKED BY:	APPROVED BY:
CUMMRM	KUZMKMW	KLAMJJR
DWG TYPE:	SCALE:	ISSUE DATE:
	AS SHOWN	11/18/2015

SHEET NO.: 19 OF 65

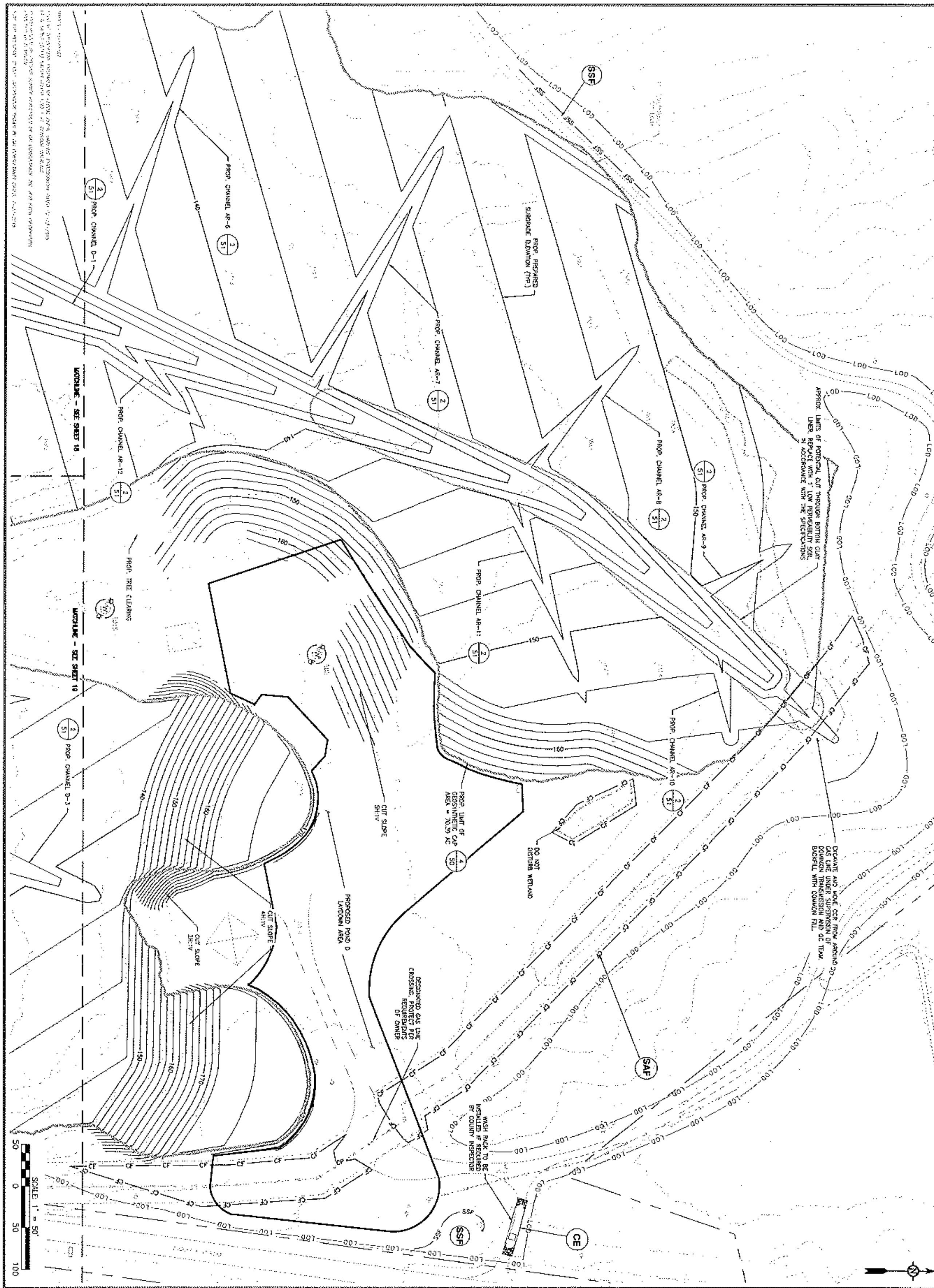
REVISION

GAI FILE NUMBER:
C150132-00-000-C-D1-014

ALT./CLIENT DRAWING NUMBER:

GAI DRAWING NUMBER:
019

PERMIT



DRAWING TITLE		
PHASE 1 GRADING PLAN ENLARGEMENT - POND D CLOSURE (SHEET 7 OF 7)		
PROJECT		CLIENT
POSSUM POINT POWER STATION COAL COMBUSTION RESIDUAL SURFACE IMPOUNDMENT CLOSURES DUMFRIES, VA	gai consultants	VIRGINIA ELECTRIC AND POWER COMPANY GLEN ALLEN, VA
ISSUING OFFICE: Richmond | 4198 Cox Road, Suite 114, Glen Allen, VA 23060		

DRAWN BY:	CHECKED BY:	APPROVED BY:
CLM/MRM	KUZ/MXMW	XLA/MLLR
DWG TYPE:	SCALE:	ISSUE DATE:
	AS SHOWN	11/18/2015

SHEET NO.: 20 OF 65

REVISION: △

GAI FILE NUMBER: C150132-00-000-C-D1-014

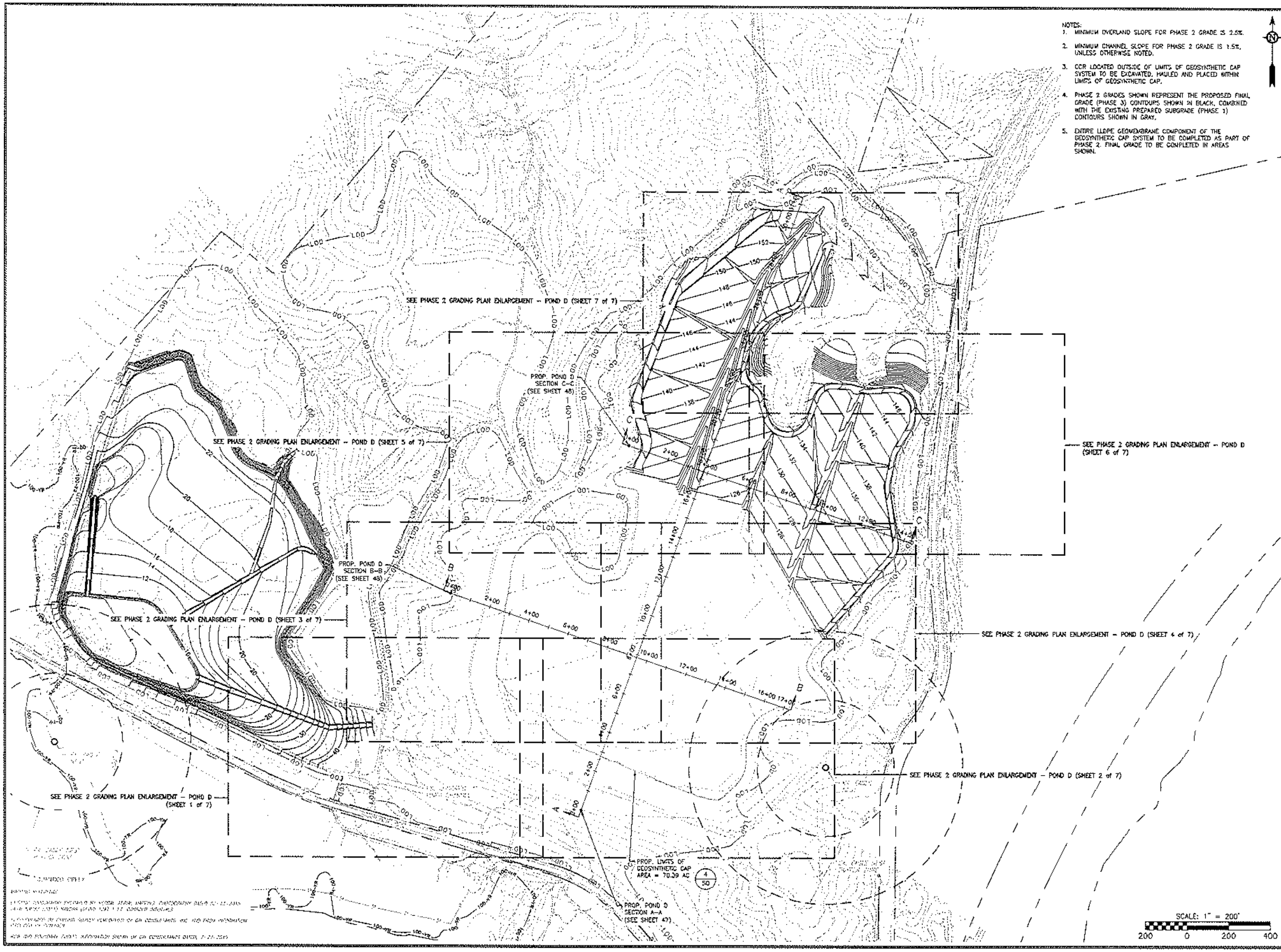
ALT/CLIENT DRAWING NUMBER:

GAI DRAWING NUMBER: 020

PERMIT

NO.	DATE	DWN	CHK	APV	DESCRIPTION

REVISION RECORD



NOTES:
1. MINIMUM OVERLAND SLOPE FOR PHASE 2 GRADE IS 2.5%.
2. MINIMUM CHANNEL SLOPE FOR PHASE 2 GRADE IS 1.5%, UNLESS OTHERWISE NOTED.
3. CCR LOCATED OUTSIDE OF LIMITS OF GEOSYNTHETIC CAP SYSTEM TO BE EXCAVATED, HAULED AND PLACED WITHIN LIMITS OF GEOSYNTHETIC CAP.
4. PHASE 2 GRADES SHOWN REPRESENT THE PROPOSED FINAL GRADE (PHASE 3) CONTOURS SHOWN IN BLACK, COMBINED WITH THE EXISTING PREPARED SUBGRADE (PHASE 1) CONTOURS SHOWN IN GRAY.
5. ENTIRE LLDPE GEOMEMBRANE COMPONENT OF THE GEOSYNTHETIC CAP SYSTEM TO BE COMPLETED AS PART OF PHASE 2. FINAL GRADE TO BE COMPLETED IN AREAS SHOWN.

NO.	DATE	DWN	CHK	APV	DESCRIPTION

REVISION RECORD

DRAWING TITLE: OVERALL PHASE 2 GRADING PLAN - POND D CLOSURE

PROJECT: POSSUM POINT POWER STATION COAL COMBUSTION RESIDUAL SURFACE IMPOUNDMENT CLOSURES DUMFRIES, VA

gai consultants

CLIENT: VIRGINIA ELECTRIC AND POWER COMPANY GLEN ALLEN, VA

ISSUING OFFICE: Richmond | 4198 Cox Road, Suite 114, Glen Allen, VA 23060

COMMONWEALTH OF VIRGINIA JOHN R. KLAMUT Lic. No. [illegible] 11/18/2015 PROFESSIONAL ENGINEER

DRAWN BY:	CHECKED BY:	APPROVED BY:
CUMMIRM	KUZMXMW	KLAMUJR
DWG TYPE:	SCALE:	ISSUE DATE:
	AS SHOWN	11/18/2015

SHEET NO.: 21 OF 65

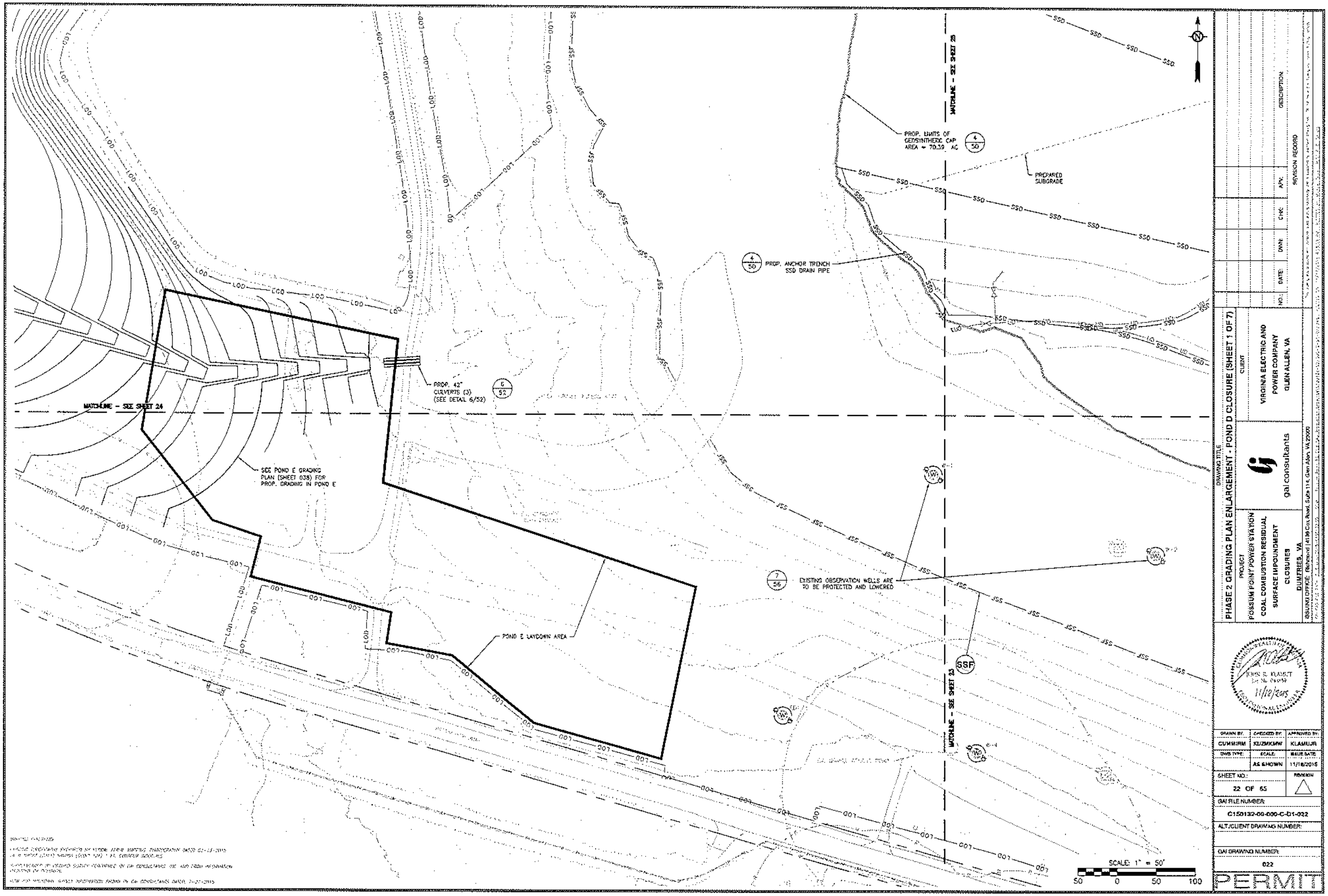
REVISION: △

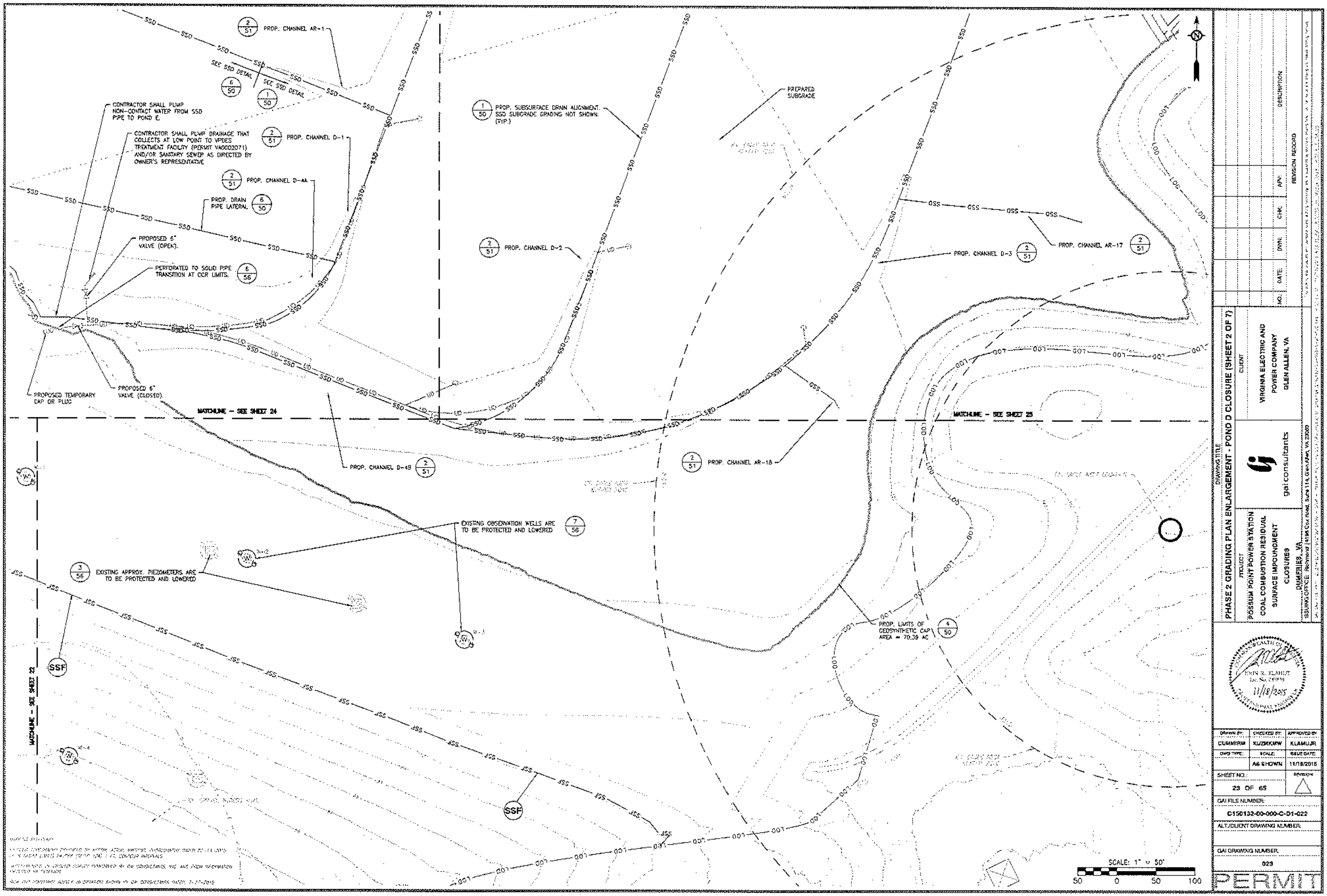
GAI FILE NUMBER: C150132-00-000-C-D1-021

ALT./CLIENT DRAWING NUMBER:

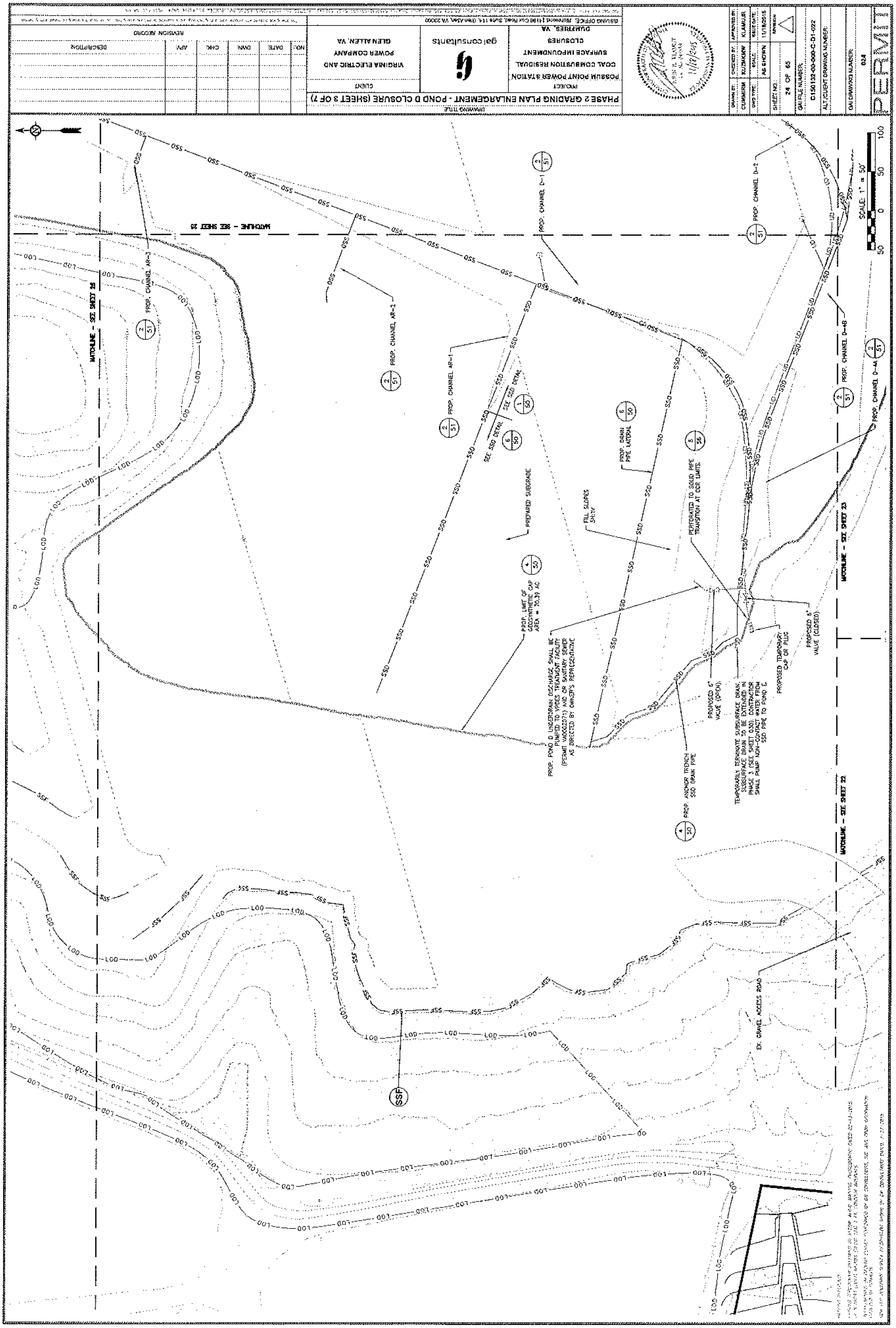
GAI DRAWING NUMBER: 021

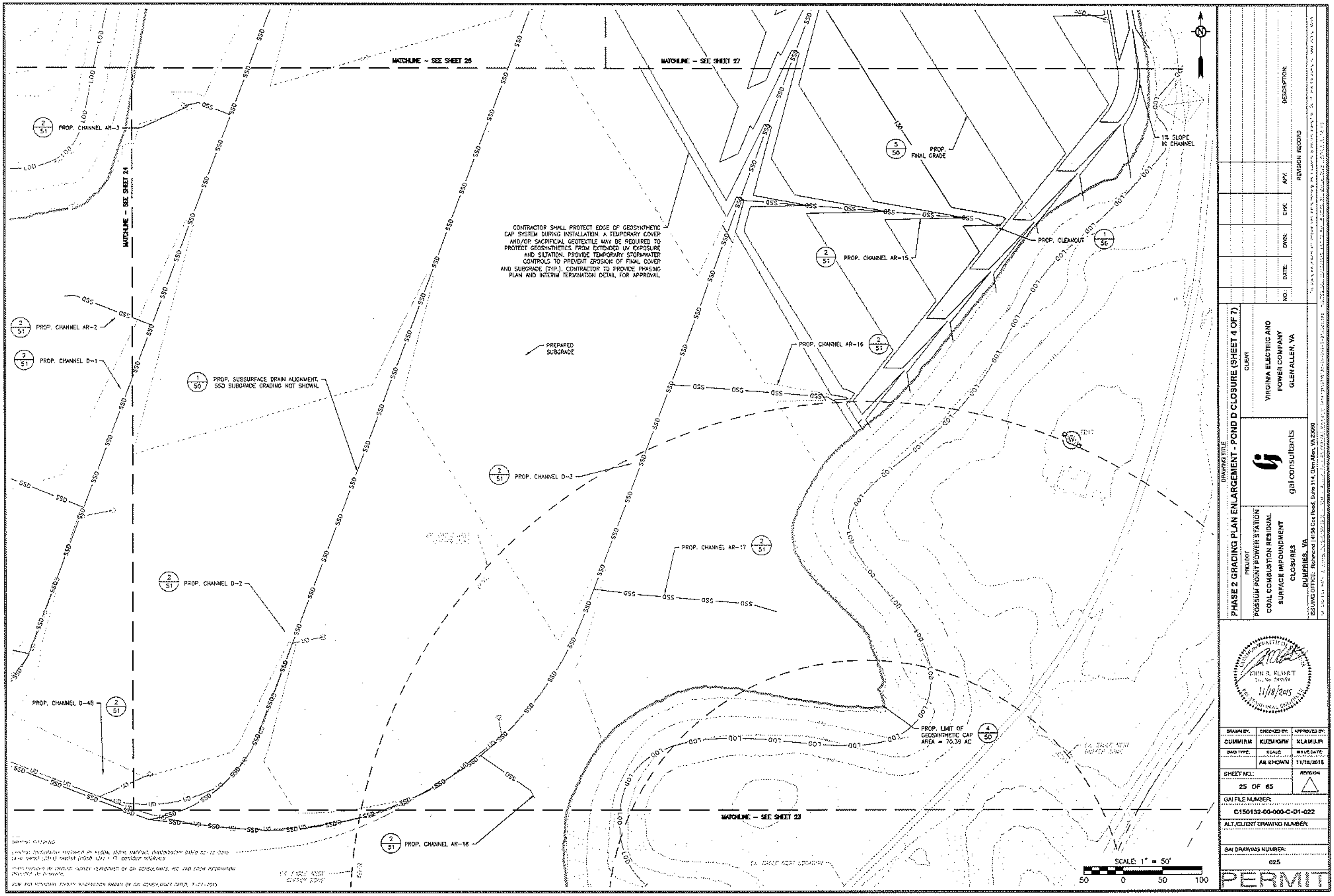
PERMIT

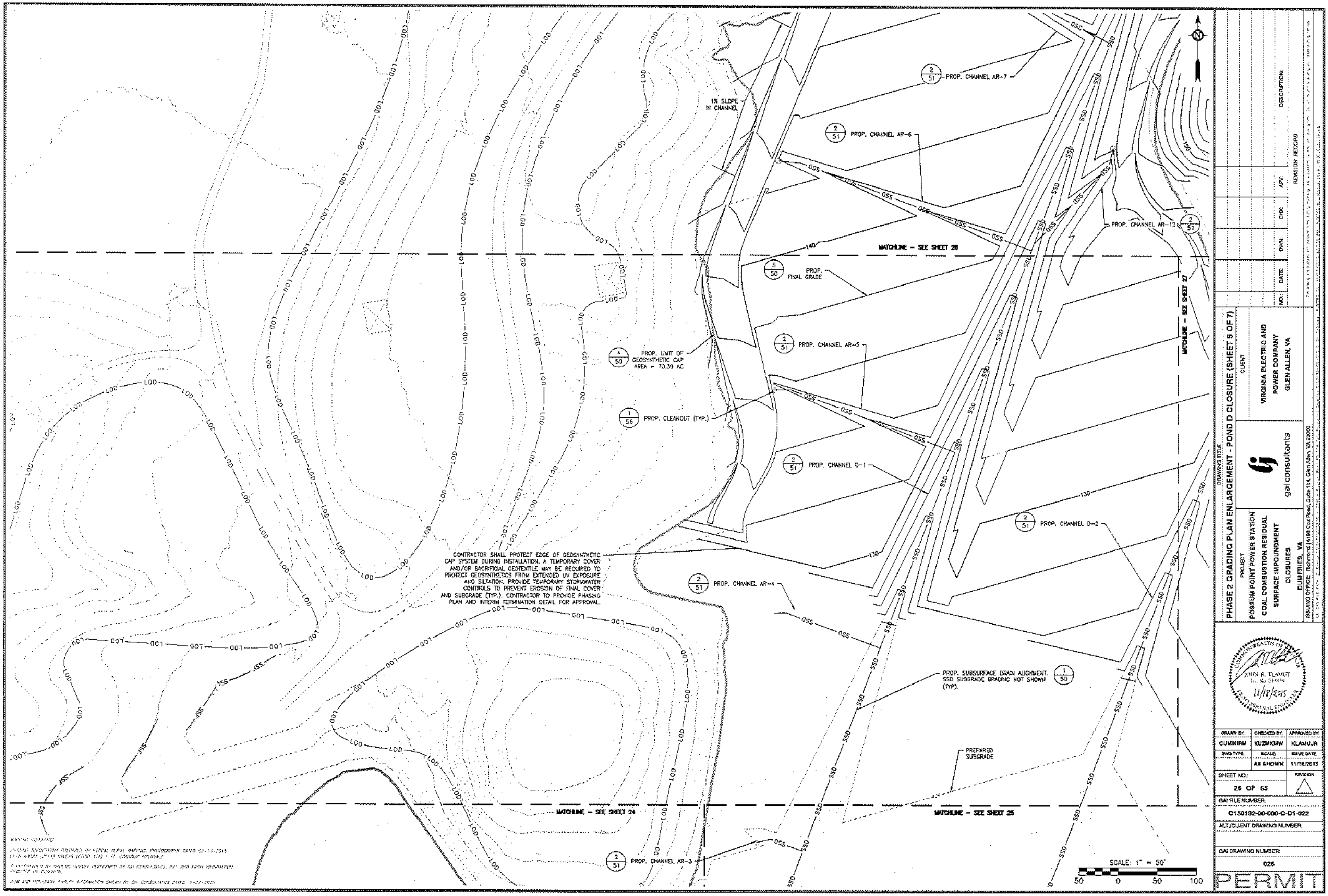

PROP. LIMITS OF GEOSYNTHETIC CAP AREA = 70.39 AC
PREPARED SUBGRADE
MATCHLINE - SEE SHEET 25
PROP. ANCHOR TRENCH SSD DRAIN PIPE
PROP. 42" CULVERTS (3) (SEE DETAIL 6/52)
MATCHLINE - SEE SHEET 24
SEE POND E GRADING PLAN (SHEET 038) FOR PROP. GRADING IN POND E
EXISTING OBSERVATION WELLS ARE TO BE PROTECTED AND LOWERED
POND E LAYDOWN AREA
MATCHLINE - SEE SHEET 23
SSF
SCALE: 1" = 50'
50 0 50 100
REVISION RECORD
NO. DATE: DWN: CHK: APV: DESCRIPTION:
DRAWING TITLE
PHASE 2 GRADING PLAN ENLARGEMENT - POND D CLOSURE (SHEET 1 OF 7)
PROJECT
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA
gai consultants
CLIENT
VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA
11/18/2015
DRAWN BY: CUMMIRM
CHECKED BY: KUZMKMW
APPROVED BY: KLAMUJR
DWG TYPE:
SCALE: AS SHOWN
ISSUE DATE: 11/18/2015
SHEET NO.: 22 OF 65
REVISION
GAI FILE NUMBER: C150132-00-000-C-D1-022
ALT./CLIENT DRAWING NUMBER:
GAI DRAWING NUMBER: 022
PERMIT



PROP. CHANNEL AR-1
SEE SSD DETAIL
SEE SSD DETAIL
CONTRACTOR SHALL PUMP NON-CONTACT WATER FROM SSD PIPE TO POND E.
CONTRACTOR SHALL PUMP DRAINAGE THAT COLLECTS AT LOW POINT TO VPDES TREATMENT FACILITY (PERMIT VA0002071) AND/OR SANITARY SEWER AS DIRECTED BY OWNER'S REPRESENTATIVE
PROP. CHANNEL D-1
PROP. CHANNEL D-4A
PROP. DRAIN PIPE LATERAL
PROPOSED 6" VALVE (OPEN).
PERFORATED TO SOLID PIPE TRANSITION AT CCR LIMITS.
PROPOSED TEMPORARY CAP OR PLUG
PROPOSED 6" VALVE (CLOSED).
PROP. SUBSURFACE DRAIN ALIGNMENT. SSD SUBGRADE GRADING NOT SHOWN. (TYP.)
PREPARED SUBGRADE
PROP. CHANNEL D-2
PROP. CHANNEL D-3
PROP. CHANNEL AR-17
MATCHLINE - SEE SHEET 24
MATCHLINE - SEE SHEET 25
MATCHLINE - SEE SHEET 22
PROP. CHANNEL D-4B
PROP. CHANNEL AR-18
EXISTING OBSERVATION WELLS ARE TO BE PROTECTED AND LOWERED
EXISTING APPROX. PIEZOMETERS ARE TO BE PROTECTED AND LOWERED
PROP. LIMITS OF GEOSYNTHETIC CAP AREA = 70.39 AC
SSF
SCALE: 1" = 50'
50 0 50 100
DRAWING TITLE
PHASE 2 GRADING PLAN ENLARGEMENT - POND D CLOSURE (SHEET 2 OF 7)
PROJECT
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA
gai consultants
CLIENT
VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA
REVISION RECORD
NO. DATE DWN. CHK. APP. DESCRIPTION
DRAWN BY: CUMMIRM
CHECKED BY: KUZMKMW
APPROVED BY: KLAMUJR
DWG TYPE:
SCALE: AS SHOWN
ISSUE DATE: 11/18/2015
SHEET NO.: 23 OF 65
REVISION
GAI FILE NUMBER: C150132-00-000-C-D1-022
ALT./CLIENT DRAWING NUMBER:
GAI DRAWING NUMBER: 023
PERMIT


PHASE 2 GRADING PLAN ENLARGEMENT - POND D CLOSURE (SHEET 3 OF 7)
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA
gai consultants
VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA
REVISION RECORD
24 OF 65
PERMIT
SCALE: 1" = 50'


MATCHLINE – SEE SHEET 26
MATCHLINE – SEE SHEET 27
MATCHLINE – SEE SHEET 24
MATCHLINE – SEE SHEET 23
PROP. CHANNEL AR-3
PROP. CHANNEL AR-2
PROP. CHANNEL D-1
PROP. SUBSURFACE DRAIN ALIGNMENT. SSD SUBGRADE GRADING NOT SHOWN.
PROP. CHANNEL D-3
PROP. CHANNEL D-2
PROP. CHANNEL D-4B
PROP. CHANNEL AR-18
PROP. CHANNEL AR-17
PROP. CHANNEL AR-16
PROP. CHANNEL AR-15
PROP. FINAL GRADE
PROP. CLEANOUT
1% SLOPE IN CHANNEL
PREPARED SUBGRADE
CONTRACTOR SHALL PROTECT EDGE OF GEOSYNTHETIC CAP SYSTEM DURING INSTALLATION. A TEMPORARY COVER AND/OR SACRIFICIAL GEOTEXTILE MAY BE REQUIRED TO PROTECT GEOSYNTHETICS FROM EXTENDED UV EXPOSURE AND SILTATION. PROVIDE TEMPORARY STORMWATER CONTROLS TO PREVENT EROSION OF FINAL COVER AND SUBGRADE (TYP.). CONTRACTOR TO PROVIDE PHASING PLAN AND INTERIM TERMINATION DETAIL FOR APPROVAL.
PROP. LIMIT OF GEOSYNTHETIC CAP AREA = 70.39 AC
SCALE: 1" = 50'
50 0 50 100
DRAWING TITLE
PHASE 2 GRADING PLAN ENLARGEMENT - POND D CLOSURE (SHEET 4 OF 7)
PROJECT
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA
gai consultants
CLIENT
VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA
ISSUING OFFICE: Richmond | 4198 Cox Road, Suite 114, Glen Allen, VA 23060
NO. DATE: DWN: CHK: APV: DESCRIPTION:
REVISION RECORD
JOHN R. KLAMUT
11/18/2015
DRAWN BY: CUMMIRM
CHECKED BY: KUZMKMW
APPROVED BY: KLAMUJR
DWG TYPE:
SCALE: AS SHOWN
ISSUE DATE: 11/18/2015
SHEET NO.: 25 OF 65
REVISION:
GAI FILE NUMBER: C150132-00-000-C-D1-022
ALT./CLIENT DRAWING NUMBER:
GAI DRAWING NUMBER: 025
PERMIT


PROP. CHANNEL AR-7
PROP. CHANNEL AR-6
PROP. CHANNEL AR-12
1% SLOPE IN CHANNEL
MATCHLINE - SEE SHEET 28
MATCHLINE - SEE SHEET 27
PROP. FINAL GRADE
PROP. CHANNEL AR-5
PROP. LIMIT OF GEOSYNTHETIC CAP AREA = 73.39 AC
PROP. CLEANOUT (TYP.)
PROP. CHANNEL D-1
PROP. CHANNEL D-2
CONTRACTOR SHALL PROTECT EDGE OF GEOSYNTHETIC CAP SYSTEM DURING INSTALLATION. A TEMPORARY COVER AND/OR SACRIFICIAL GEOTEXTILE MAY BE REQUIRED TO PROTECT GEOSYNTHETICS FROM EXTENDED UV EXPOSURE AND SILTATION. PROVIDE TEMPORARY STORMWATER CONTROLS TO PREVENT EROSION OF FINAL COVER AND SUBGRADE (TYP.). CONTRACTOR TO PROVIDE PHASING PLAN AND INTERIM TERMINATION DETAIL FOR APPROVAL.
PROP. CHANNEL AR-4
PROP. SUBSURFACE DRAIN ALIGNMENT. SSD SUBGRADE GRADING NOT SHOWN (TYP).
PREPARED SUBGRADE
MATCHLINE - SEE SHEET 24
MATCHLINE - SEE SHEET 25
PROP. CHANNEL AR-3
SCALE: 1" = 50'
50 0 50 100
REVISION RECORD
NO. DATE DWN. CHK. APV. DESCRIPTION
DRAWING TITLE
PHASE 2 GRADING PLAN ENLARGEMENT - POND D CLOSURE (SHEET 5 OF 7)
PROJECT
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA
CLIENT
VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA
gai consultants
JOHN R. KLAMUT
11/18/2015
DRAWN BY: CUNKMRM
CHECKED BY: KUZMKJW
APPROVED BY: KLAMUJA
DWG TYPE:
SCALE: AS SHOWN
ISSUE DATE: 11/18/2015
SHEET NO.: 26 OF 65
REVISION
GAI FILE NUMBER: C150132-00-000-C-D1-022
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GAI DRAWING NUMBER: 026
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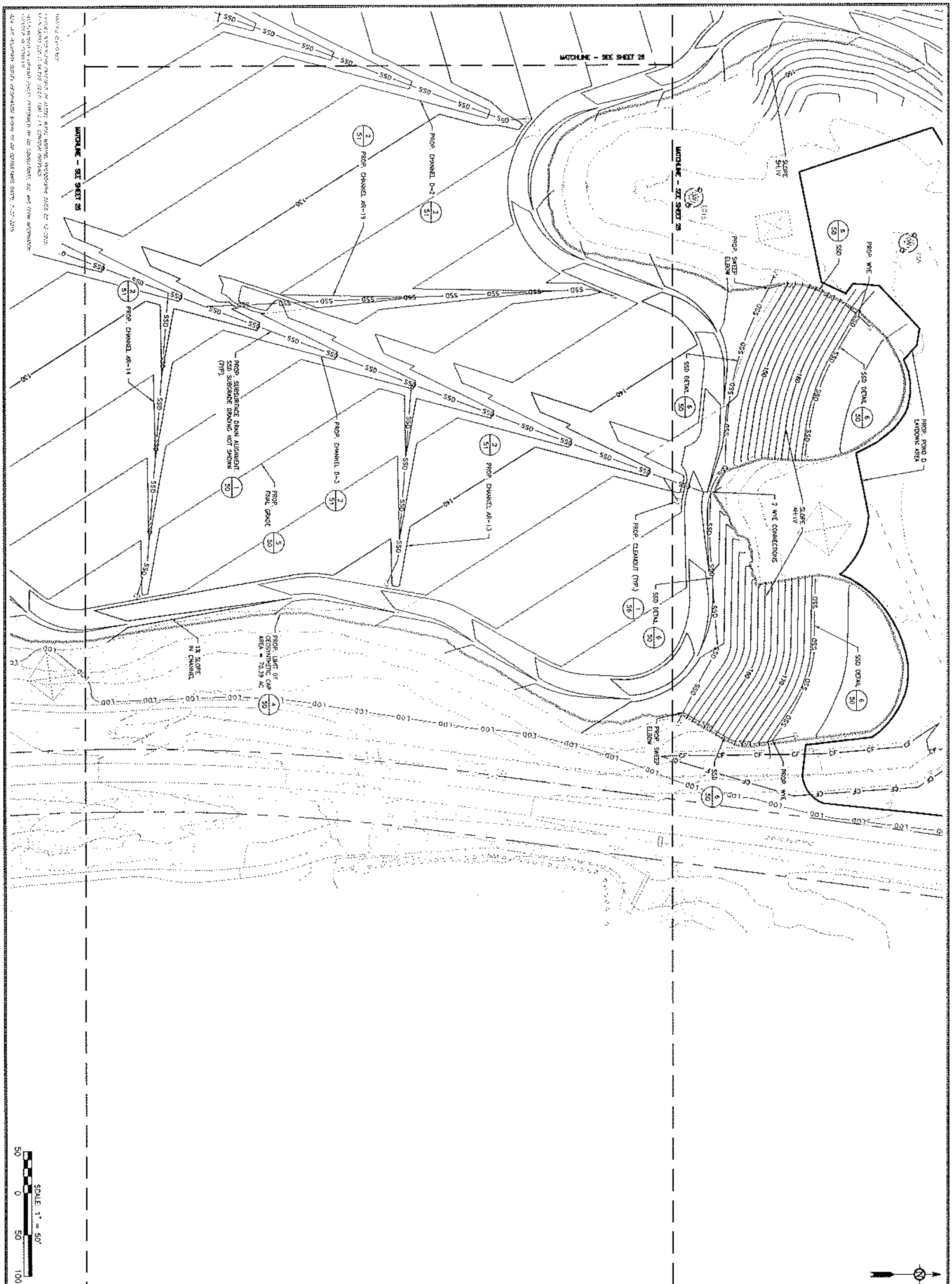

DRAWING TITLE	PHASE 2 GRADING PLAN ENLARGEMENT - POND D CLOSURE (SHEET 6 OF 7)
PROJECT	POSSUM POINT POWER STATION COAL COMBUSTION RESIDUAL SURFACE IMPOUNDMENT CLOSURES DUMFRIES, VA
CLIENT	VIRGINIA ELECTRIC AND POWER COMPANY GLEN ALLEN, VA

gai consultants

ISSUING OFFICE: Richmond | 4198 Cox Road, Suite 114, Glen Allen, VA 23060

NO.:	DATE:	DWN:	CHK:	APV:	DESCRIPTION:

REVISION RECORD

DRAWN BY:	CHECKED BY:	APPROVED BY:
CUMMIRM	KUZMOKW	KLAMUJR
DWG TYPE:	SCALE:	ISSUE DATE:
	AS SHOWN	11/18/2015

SHEET NO.: 27 OF 65

REVISION: △

GAI FILE NUMBER: C150132-00-000-C-01-022

ALT./CLIENT DRAWING NUMBER:

GAI DRAWING NUMBER: 027

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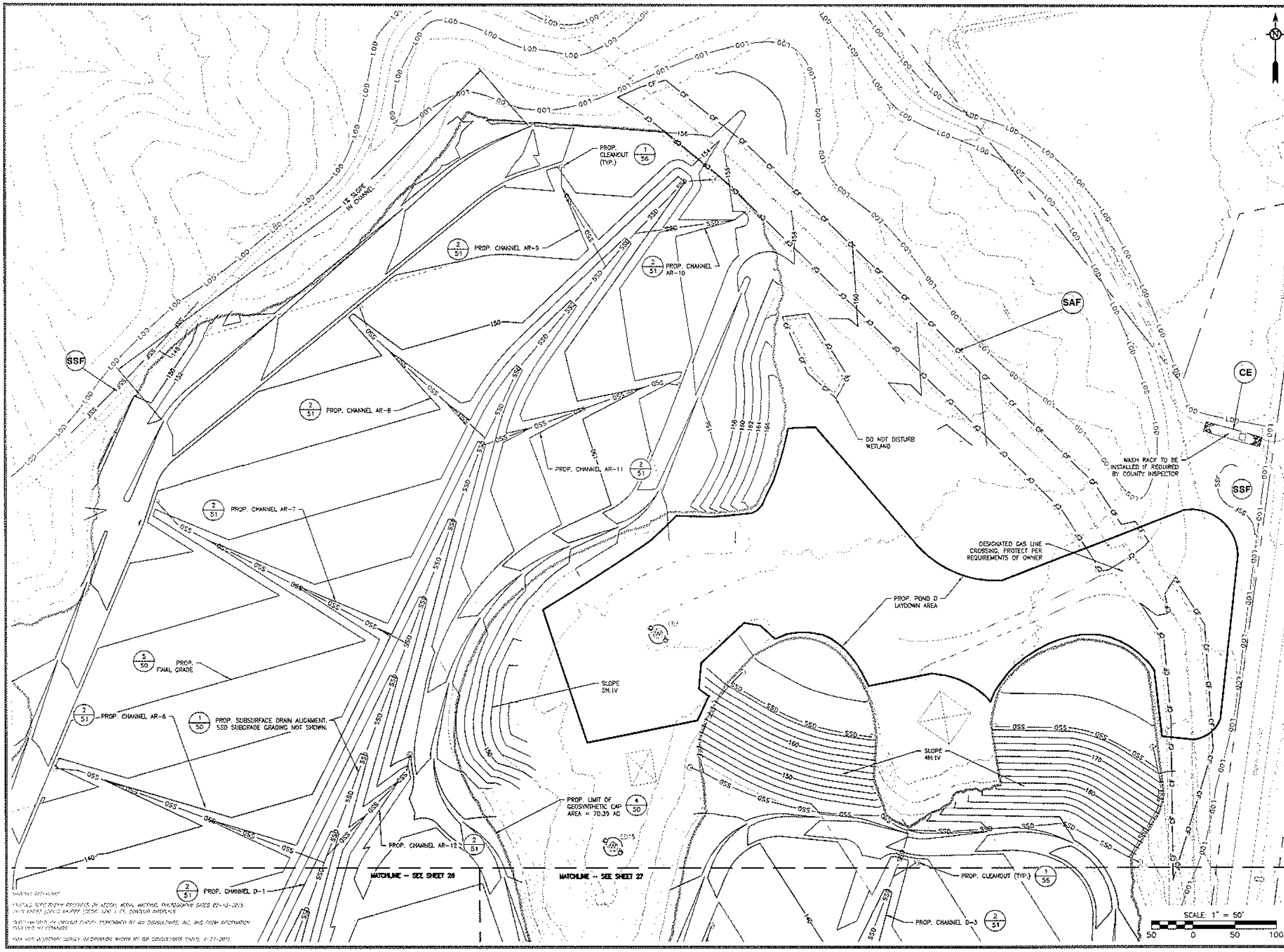

NO.	DATE:	DWN:	CHK:	APV:	DESCRIPTION

REVISION RECORD

DRAWING TITLE
PHASE 2 GRADING PLAN ENLARGEMENT - POND D CLOSURE (SHEET 7 OF 7)

PROJECT
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA

CLIENT
VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA

gaiconsultants

ISSUING OFFICE: Richmond | 4198 Cox Road, Suite 114, Glen Allen, VA 23060

JOHN R. KLAMUT
Lic. No. 24959
11/18/2015

DRAWN BY:	CHECKED BY:	APPROVED BY:
CUMMIRM	KUZMKMW	KLAMUJR
DWG TYPE:	SCALE:	ISSUE DATE:
	AS SHOWN	11/18/2015

SHEET NO.: 28 OF 65
REVISION

GAI FILE NUMBER:
C150132-00-000-C-D1-022

ALT./CLIENT DRAWING NUMBER:

GAI DRAWING NUMBER:
028

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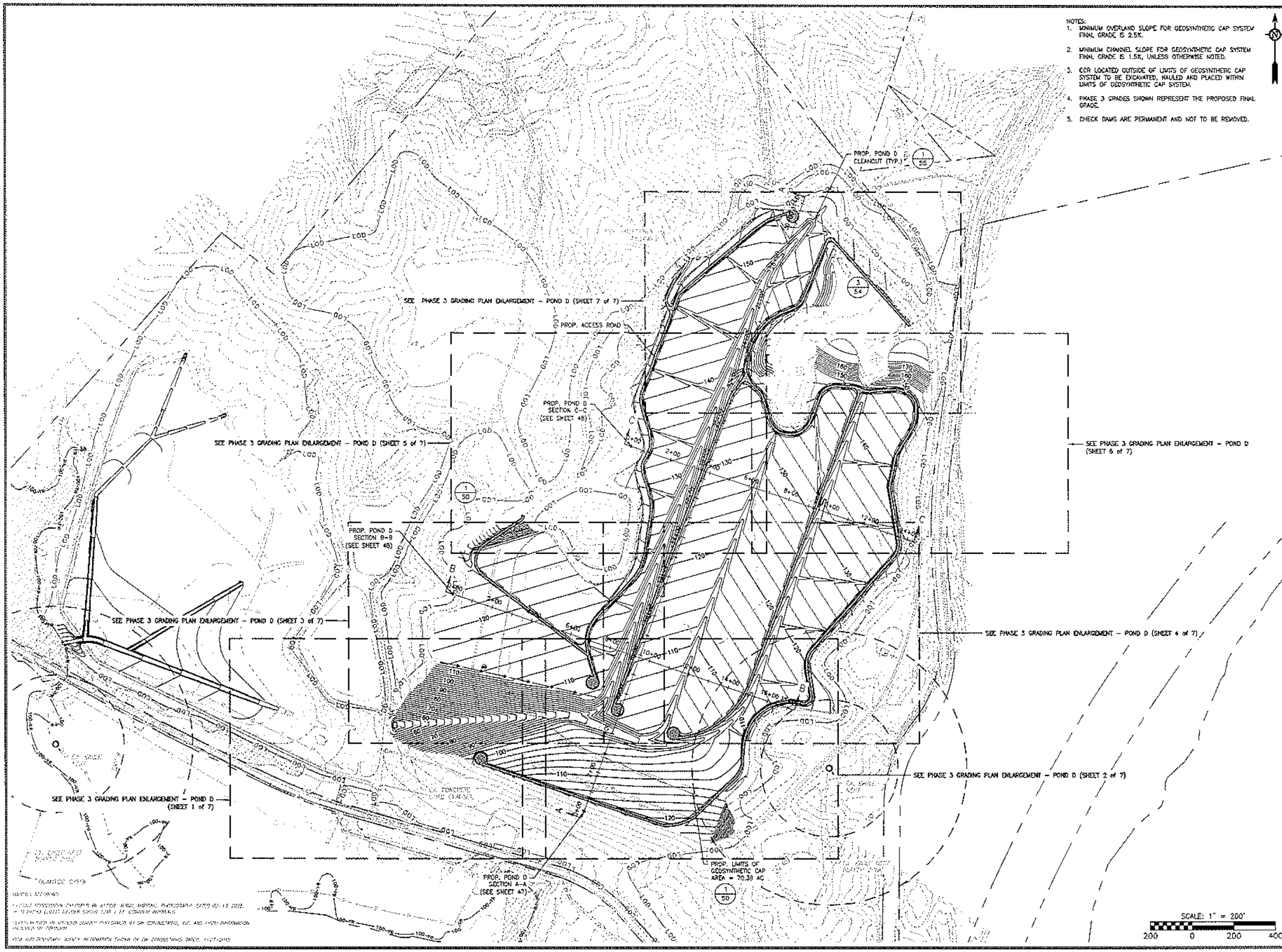


NOTES:

1. MINIMUM OVERLAND SLOPE FOR GEOSYNTHETIC CAP SYSTEM FINAL GRADE IS 2.5%.
2. MINIMUM CHANNEL SLOPE FOR GEOSYNTHETIC CAP SYSTEM FINAL GRADE IS 1.5%, UNLESS OTHERWISE NOTED.
3. CCR LOCATED OUTSIDE OF LIMITS OF GEOSYNTHETIC CAP SYSTEM TO BE EXCAVATED, HAULED AND PLACED WITHIN LIMITS OF GEOSYNTHETIC CAP SYSTEM.
4. PHASE 3 GRADES SHOWN REPRESENT THE PROPOSED FINAL GRADE.
5. CHECK DAMS ARE PERMANENT AND NOT TO BE REMOVED.

NO.	DATE	DWN.	CHK.	APV.	DESCRIPTION

REVISION RECORD

DRAWING TITLE
OVERALL PHASE 3 GRADING PLAN - POND D CLOSURE

PROJECT
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA

gai consultants

CLIENT
VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA

ISSUING OFFICE: Richmond 4198 Cox Road, Suite 114, Glen Allen, VA 23060

DRAWN BY:	CHECKED BY:	APPROVED BY:
CUMMIRM	KUZMKMW	KLAMUJR
DWG TYPE:	SCALE:	ISSUE DATE:
	AS SHOWN	11/18/2015

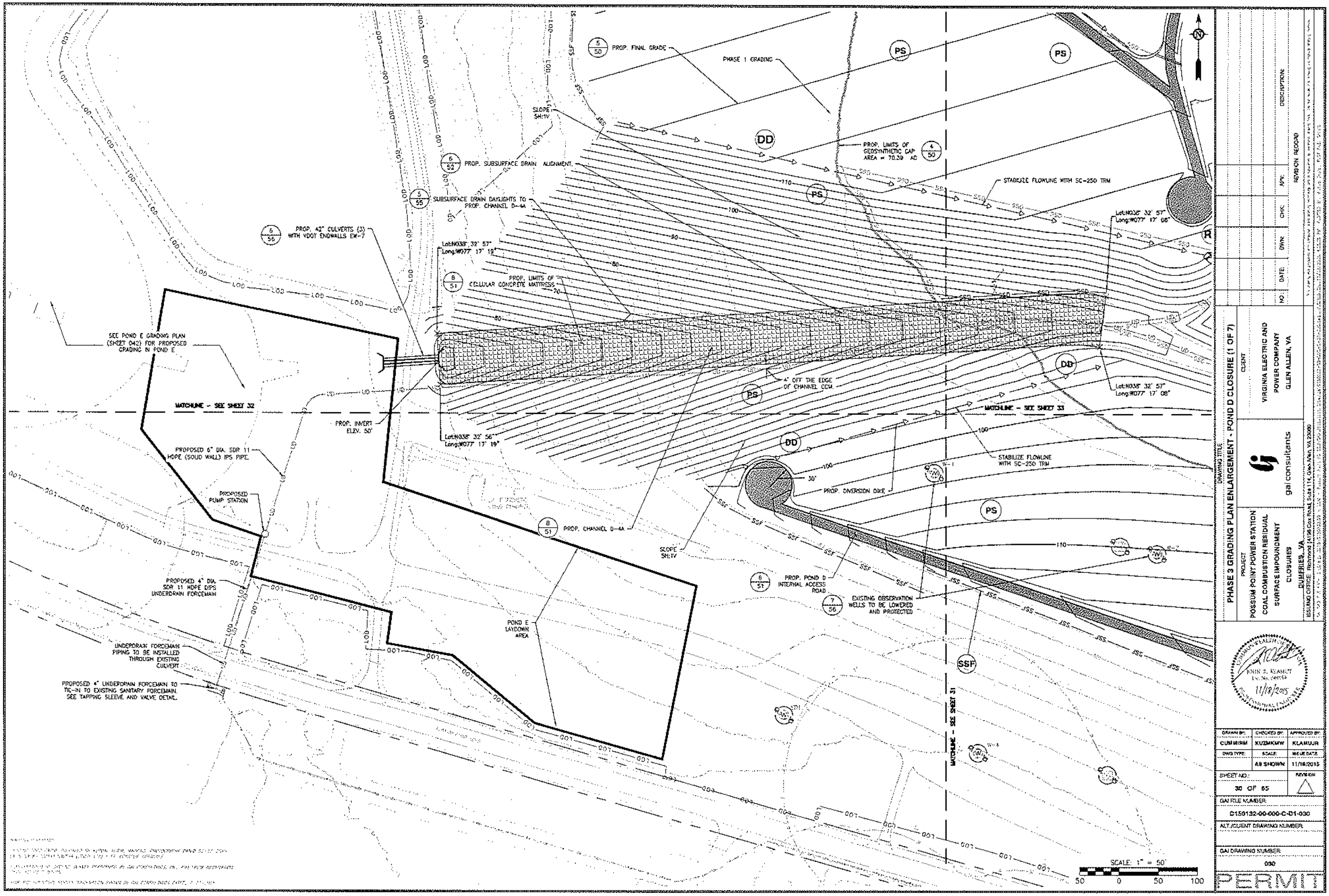
SHEET NO.: 29 OF 65 | REVISION:

GAI FILE NUMBER: C150132-00-000-C-D1-029

ALT./CLIENT DRAWING NUMBER:

GAI DRAWING NUMBER: D29

PERMIT



PROP. FINAL GRADE
PHASE 1 GRADING
PS
DD
SLOPE 5H:1V
PROP. SUBSURFACE DRAIN ALIGNMENT
PROP. LIMITS OF GEOSYNTHETIC CAP AREA = 70.39 AC
STABILIZE FLOWLINE WITH SC-250 TRM
SUBSURFACE DRAIN DAYLIGHTS TO PROP. CHANNEL D-4A
PROP. 42" CULVERTS (3) WITH VDOT ENDWALLS EW-7
Lat:N038° 32' 57"
Long:W077° 17' 19"
PROP. LIMITS OF CELLULAR CONCRETE MATTRESS
Lat:N038° 32' 57"
Long:W077° 17' 08"
SEE POND E GRADING PLAN (SHEET 042) FOR PROPOSED GRADING IN POND E
4' OFF THE EDGE OF CHANNEL CCM
MATCHLINE - SEE SHEET 32
MATCHLINE - SEE SHEET 33
MATCHLINE - SEE SHEET 31
PROP. INVERT ELEV. 50'
Lat:N038° 32' 56"
Long:W077° 17' 19"
Lat:N038° 32' 57"
Long:W077° 17' 08"
PROPOSED 6" DIA. SDR 11 HDPE (SOLID WALL) IPS PIPE.
STABILIZE FLOWLINE WITH SC-250 TRM
PROP. DIVERSION DIKE
PROPOSED PUMP STATION
PROP. CHANNEL D-4A
SLOPE 5H:1V
PROP. POND D INTERNAL ACCESS ROAD
EXISTING OBSERVATION WELLS TO BE LOWERED AND PROTECTED
PROPOSED 4" DIA. SDR 11 HDPE DIPS UNDERDRAIN FORCEMAIN
POND E LAYDOWN AREA
UNDERDRAIN FORCEMAIN PIPING TO BE INSTALLED THROUGH EXISTING CULVERT
PROPOSED 4" UNDERDRAIN FORCEMAIN TO TIE-IN TO EXISTING SANITARY FORCEMAIN. SEE TAPPING SLEEVE AND VALVE DETAIL.
SSF
SCALE: 1" = 50'
50 0 50 100
NO. DATE DWN. CHK. APV. DESCRIPTION
REVISION RECORD
DRAWING TITLE
PHASE 3 GRADING PLAN ENLARGEMENT - POND D CLOSURE (1 OF 7)
PROJECT
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA
gai consultants
CLIENT
VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA
JOHN R. KLAMUT
11/18/2015
DRAWN BY: CUM/BRM
CHECKED BY: KUZMKMW
APPROVED BY: KLAMUJR
DWG TYPE:
SCALE: AS SHOWN
ISSUE DATE: 11/18/2015
SHEET NO.: 30 OF 65
REVISION
GAI FILE NUMBER: D150132-00-000-C-D1-030
ALT./CLIENT DRAWING NUMBER:
GAI DRAWING NUMBER: 030
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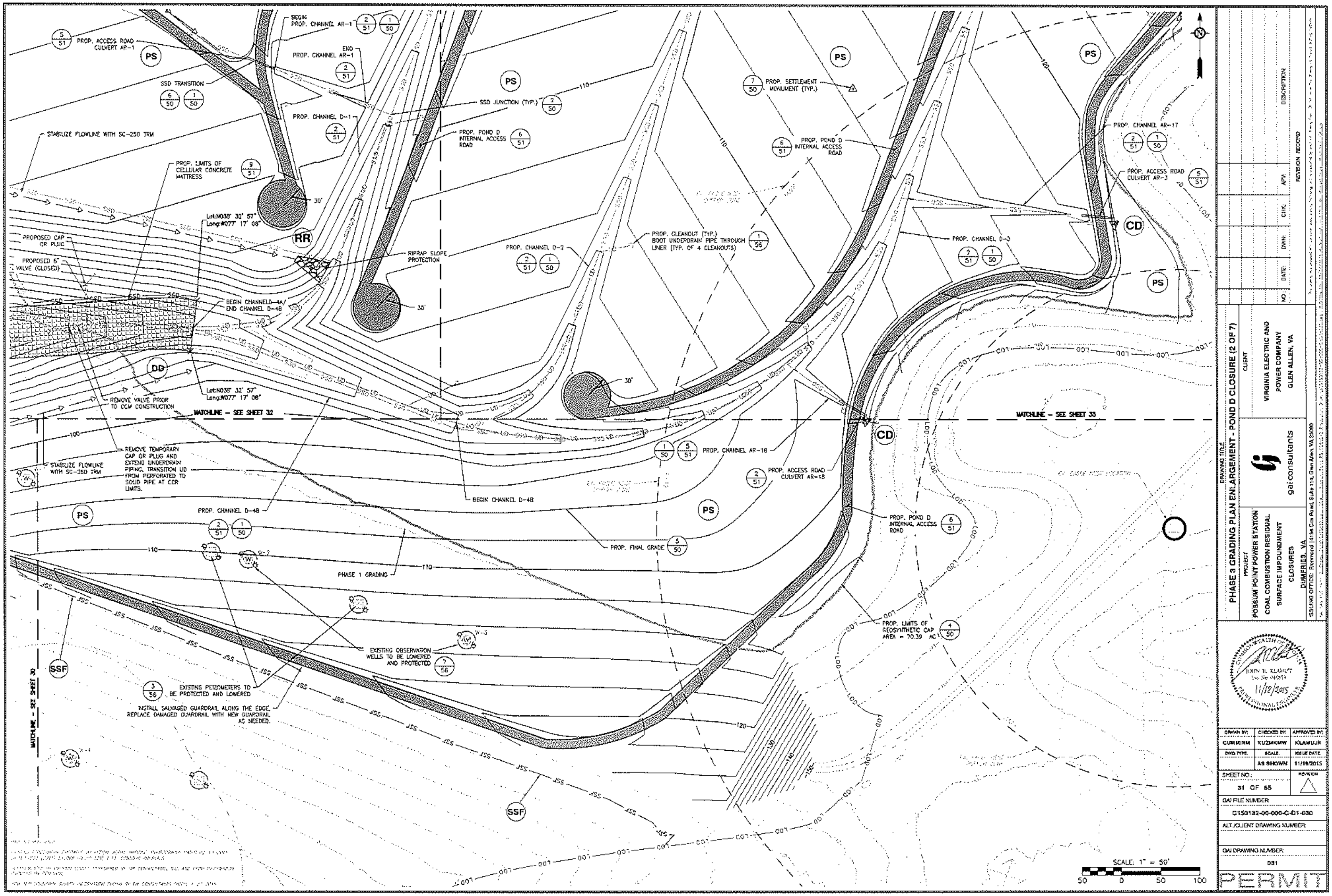
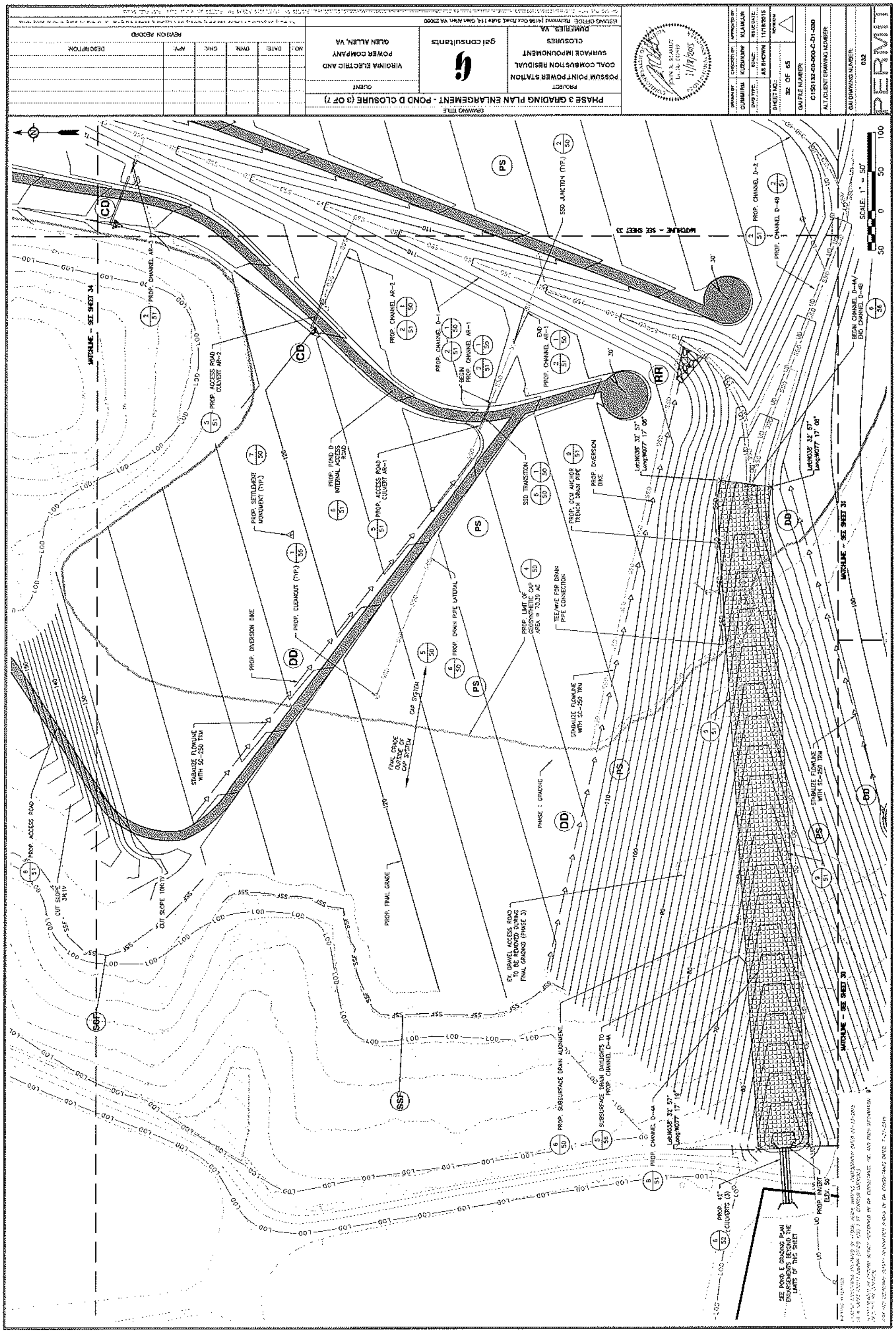
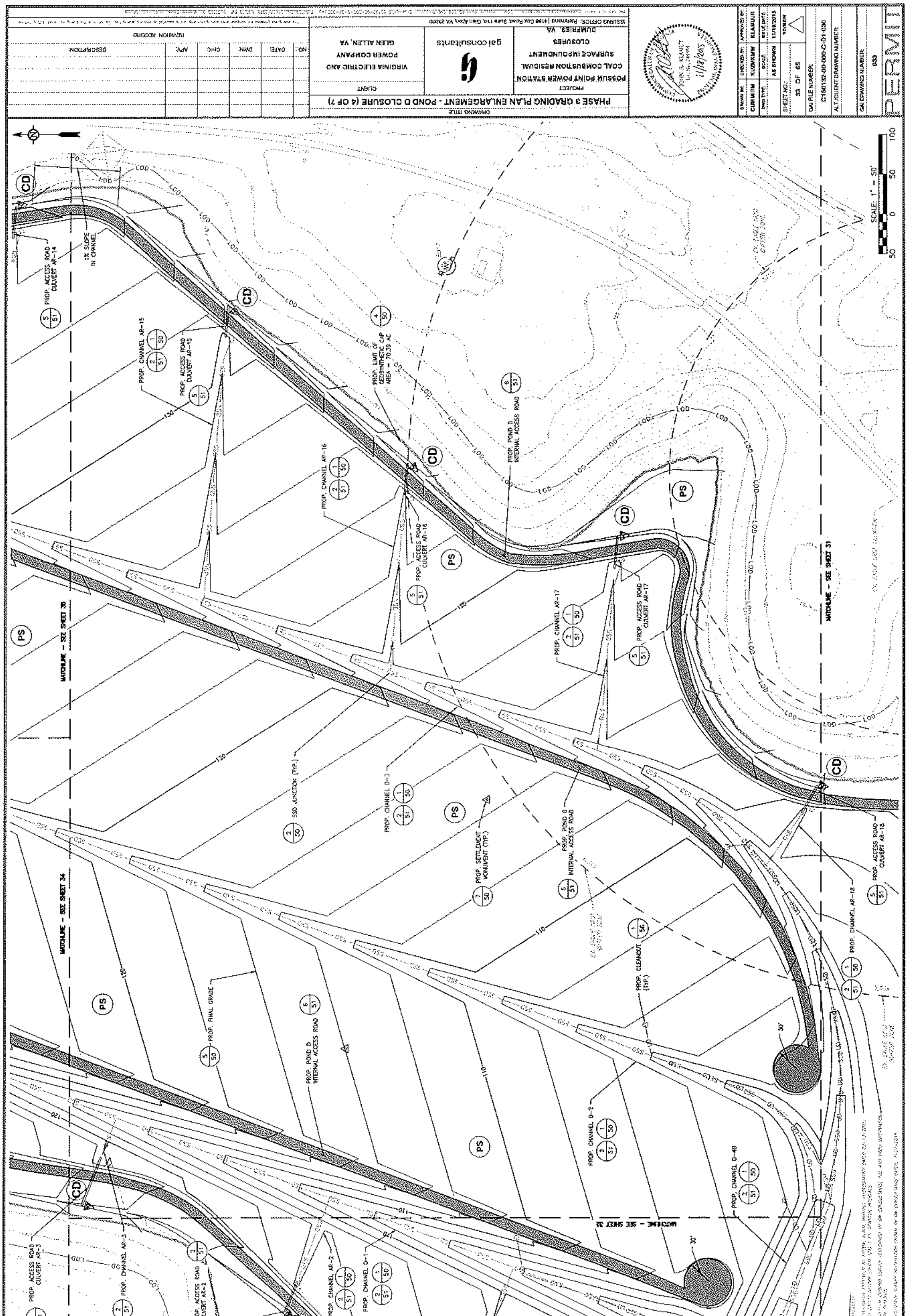
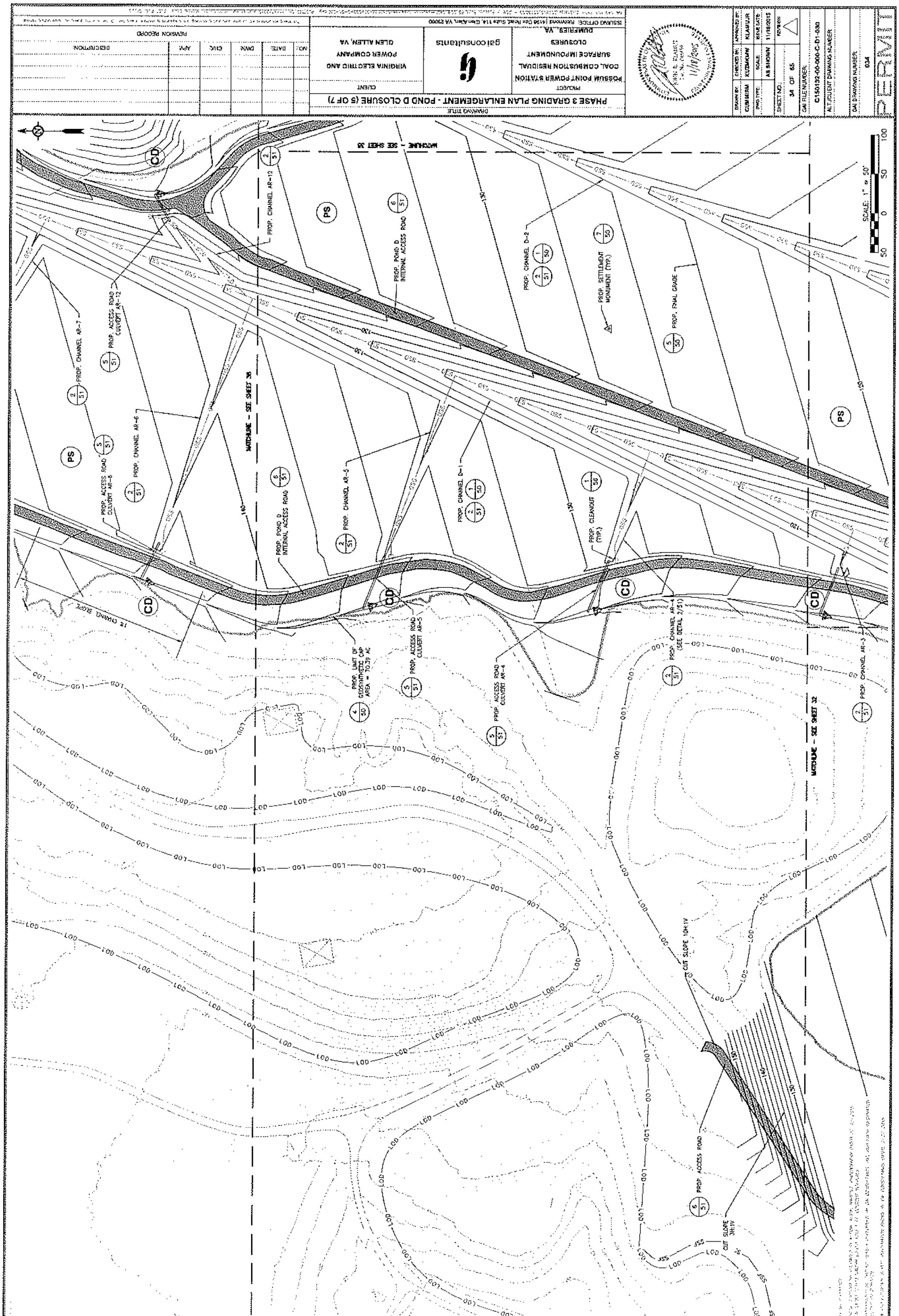
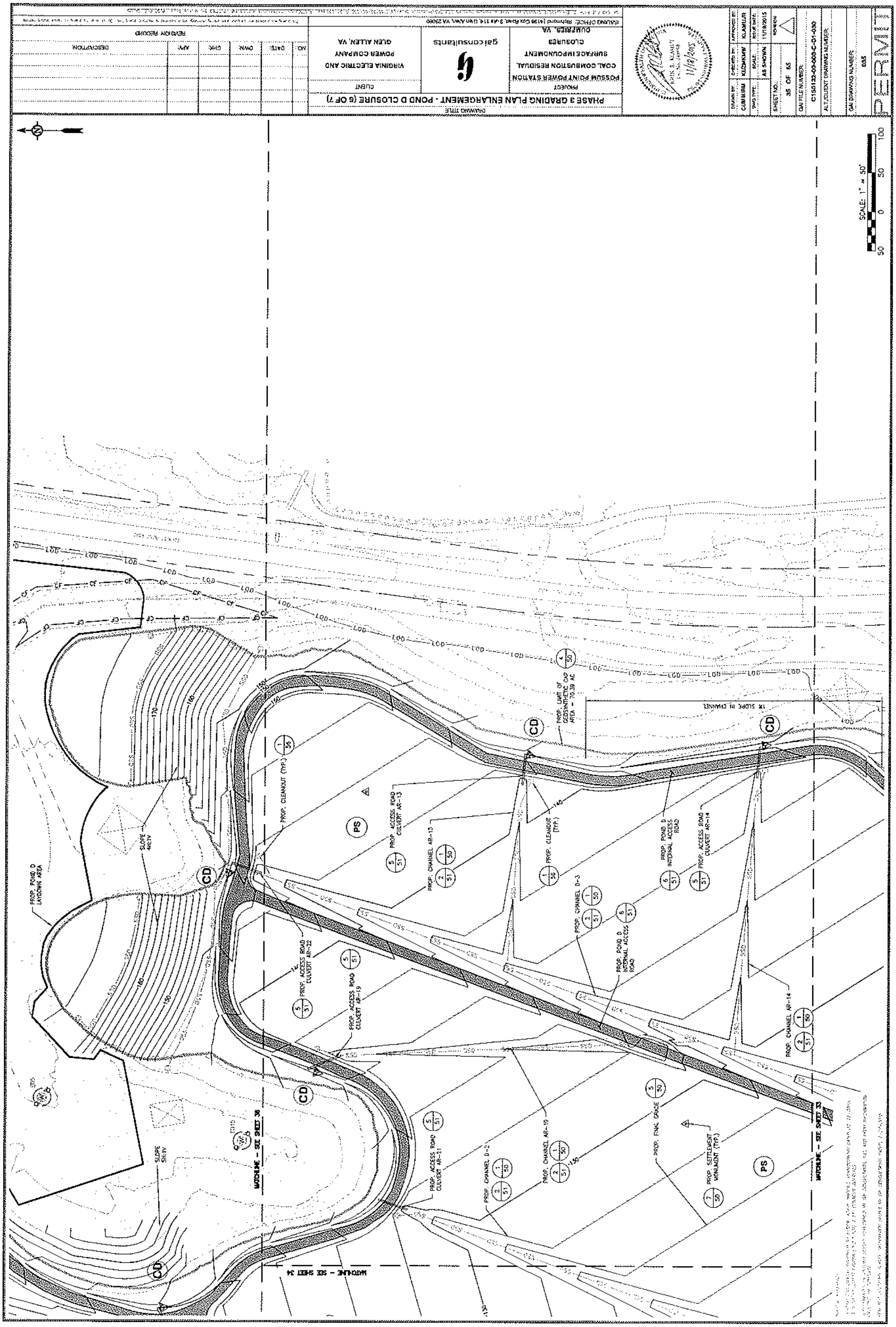
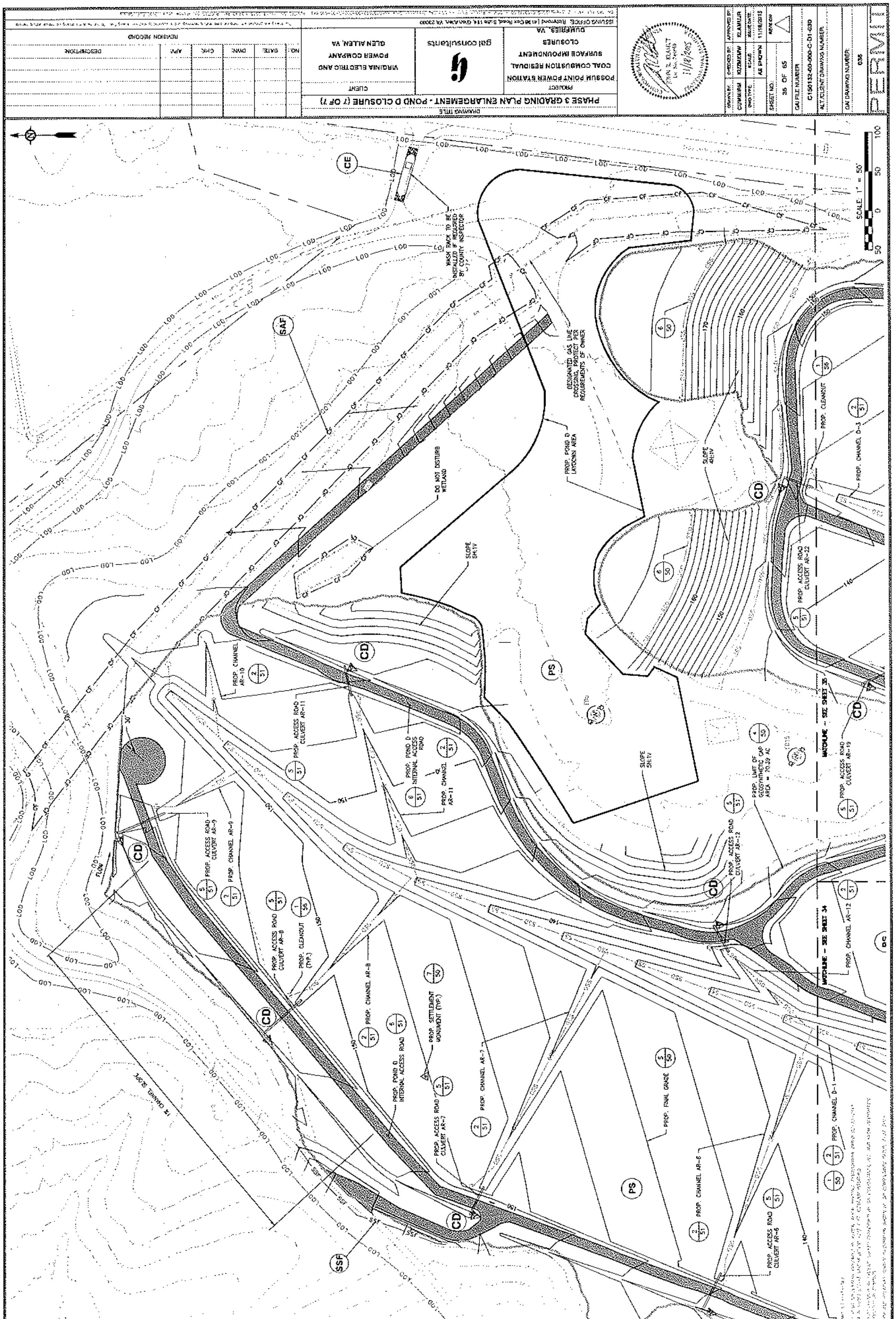

PHASE 3 GRADING PLAN ENLARGEMENT - POND D CLOSURE (2 OF 7)
DRAWING TITLE
PROJECT
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA
CLIENT
VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA
gai consultants
REVISION RECORD
NO. DATE: DWN: CHK: APV: DESCRIPTION
DRAWN BY: CUMKIRM
CHECKED BY: KUZMKMW
APPROVED BY: KLAMUJR
DWG TYPE:
SCALE: AS SHOWN
ISSUE DATE: 11/19/2015
SHEET NO.: 31 OF 65
REVISION
GAI FILE NUMBER: C150132-00-000-C-D1-030
ALT./CLIENT DRAWING NUMBER:
GAI DRAWING NUMBER: 031
PERMIT
SCALE: 1" = 50'
50 0 50 100
MATCHLINE - SEE SHEET 32
MATCHLINE - SEE SHEET 33
MATCHLINE - SEE SHEET 30
PROP. ACCESS ROAD CULVERT AR-1
BEGIN PROP. CHANNEL AR-1
END PROP. CHANNEL AR-1
SSD TRANSITION
SSD JUNCTION (TYP.)
PROP. CHANNEL D-1
PROP. POND D INTERNAL ACCESS ROAD
STABILIZE FLOWLINE WITH SC-250 TRM
PROP. LIMITS OF CELLULAR CONCRETE MATTRESS
Lat:N038° 32' 57" Long:W077° 17' 06"
PROPOSED CAP OR PLUG
PROPOSED 6" VALVE (CLOSED)
RIPRAP SLOPE PROTECTION
BEGIN CHANNEL D-4A/ END CHANNEL D-4B
REMOVE VALVE PRIOR TO CCM CONSTRUCTION
REMOVE TEMPORARY CAP OR PLUG AND EXTEND UNDERDRAIN PIPING. TRANSITION UD FROM PERFORATED TO SOLID PIPE AT CCR LIMITS.
PROP. CHANNEL D-2
PROP. CLEANOUT (TYP.) BOOT UNDERDRAIN PIPE THROUGH LINER (TYP. OF 4 CLEANOUTS)
PROP. SETTLEMENT MONUMENT (TYP.)
PROP. CHANNEL D-3
PROP. CHANNEL AR-17
PROP. ACCESS ROAD CULVERT AR-3
PROP. CHANNEL AR-18
PROP. ACCESS ROAD CULVERT AR-18
BEGIN CHANNEL D-4B
PROP. CHANNEL D-4B
PROP. FINAL GRADE
PHASE 1 GRADING
PROP. LIMITS OF GEOSYNTHETIC CAP AREA = 70.39 AC
EXISTING OBSERVATION WELLS TO BE LOWERED AND PROTECTED
EXISTING PEIZOMETERS TO BE PROTECTED AND LOWERED
INSTALL SALVAGED GUARDRAIL ALONG THE EDGE. REPLACE DAMAGED GUARDRAIL WITH NEW GUARDRAIL AS NEEDED.
PS
CD
RR
DD
SSF
30'
100
110
120

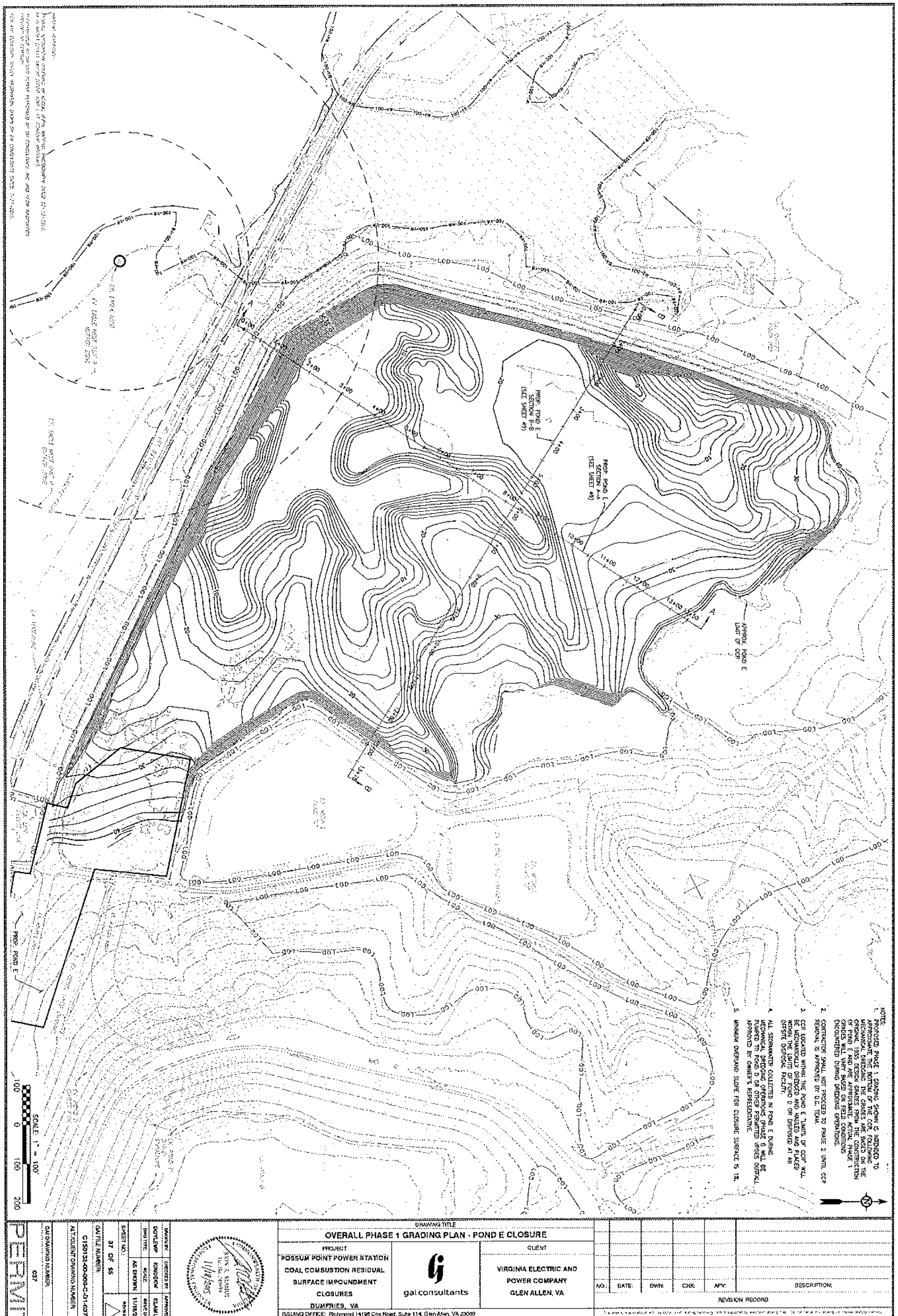

PHASE 3 GRADING PLAN ENLARGEMENT - POND D CLOSURE (3 OF 7)
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA
VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA
gai consultants
C150132-03-000-C-D1-030
SCALE: 1" = 50'
PERMIT


PHASE 3 GRADING PLAN ENLARGEMENT - POND D CLOSURE (4 OF 7)
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA
VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA
gai consultants
33 OF 65
PERMIT
SCALE: 1" = 50'


PHASE 3 GRADING PLAN ENLARGEMENT - POND D CLOSURE (5 OF 7)
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA
VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA
gaiconsultants
34 OF 65
C150132-00-000-C-D1-030
034
PERMIT
SCALE: 1" = 50'
MATCHLINE - SEE SHEET 35
MATCHLINE - SEE SHEET 36
MATCHLINE - SEE SHEET 32
PROP. FINAL GRADE
PROP. SETTLEMENT MONUMENT (TYP.)
PROP. CLEANOUT (TYP.)
PROP. ACCESS ROAD
CUT SLOPE 10H:1V


PHASE 3 GRADING PLAN ENLARGEMENT - POND D CLOSURE (6 OF 7)
PROJECT
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA
gaiconsultants
CLIENT
VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA
REVISION RECORD
SHEET NO. 35 OF 65
SCALE: AS SHOWN
ISSUE DATE: 11/18/2015
C150123-00-000-C-01-030
PERMIT
SCALE: 1" = 50'
PROP. POND D LAYDOWN AREA
SLOPE 4H:1V
SLOPE 5H:1V
PROP. CLEANOUT (TYP.)
PROP. ACCESS ROAD CULVERT AR-13
PROP. CHANNEL AR-13
PROP. CHANNEL D-3
PROP. POND D INTERNAL ACCESS ROAD
PROP. ACCESS ROAD CULVERT AR-14
PROP. CHANNEL AR-14
PROP. ACCESS ROAD CULVERT AR-22
PROP. ACCESS ROAD CULVERT AR-19
PROP. ACCESS ROAD CULVERT AR-21
PROP. CHANNEL D-2
PROP. CHANNEL AR-19
PROP. FINAL GRADE
PROP. SETTLEMENT MONUMENT (TYP.)
PROP. LIMIT OF GEOSYNTHETIC CAP AREA = 70.39 AC
1% SLOPE IN CHANNEL
MATCHLINE - SEE SHEET 33
MATCHLINE - SEE SHEET 34
MATCHLINE - SEE SHEET 36
PS
CD


PHASE 3 GRADING PLAN ENLARGEMENT - POND D CLOSURE (7 OF 7)
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA
gai consultants
VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA
REVISION RECORD
35 OF 65
C150132-00-000-C-D1-030
036
SCALE: 1" = 50'
PROP. POND D LAYDOWN AREA
DO NOT DISTURB WETLAND
DESIGNATED GAS LINE CROSSING. PROTECT PER REQUIREMENTS OF OWNER
WASH RACK TO BE INSTALLED IF REQUIRED BY COUNTY INSPECTOR
PROP. FINAL GRADE
PROP. CHANNEL AR-7
PROP. CHANNEL AR-8
PROP. CHANNEL AR-9
PROP. CHANNEL AR-10
PROP. CHANNEL AR-11
PROP. CHANNEL AR-12
PROP. CHANNEL D-1
PROP. CHANNEL D-3
PROP. POND D INTERNAL ACCESS ROAD
PROP. SETTLEMENT MONUMENT (TYP.)
PROP. CLEANOUT
PROP. LIMIT OF GEOSYNTHETIC CAP
MATCHLINE - SEE SHEET 34
MATCHLINE - SEE SHEET 35


NOTES:
1. PROPOSED PHASE 1 GRADING SHOWN IS INTENDED TO APPROXIMATE THE BOTTOM OF THE CCR, FOLLOWING MECHANICAL DREDGING. THE GRADES ARE BASED ON THE ORIGINAL 1955 DESIGN GRADES FROM THE CONSTRUCTION OF POND E AND ARE APPROXIMATE. ACTUAL PHASE 1 GRADES WILL VARY BASED ON FIELD CONDITIONS ENCOUNTERED DURING DREDGING OPERATIONS.
2. CONTRACTOR SHALL NOT PROCEED TO PHASE 2 UNTIL CCP REMOVAL IS APPROVED BY O.C. TEAM.
3. CCR LOCATED WITHIN THE POND E "LIMITS OF CCR" WILL BE MECHANICALLY DREDGED AND HAULED AND PLACED WITHIN THE LIMITS OF POND D OR DISPOSED AT AN OFFSITE DISPOSAL FACILITY.
4. ALL STORMWATER COLLECTED IN POND E DURING MECHANICAL DREDGING OPERATIONS (PHASE 1) WILL BE PUMPED TO POND D OR OTHER PERMITTED VPDES OUTFALL APPROVED BY OWNER'S REPRESENTATIVE.
5. MINIMUM OVERLAND SLOPE FOR CLOSURE SURFACE IS 1%.
PROP. POND E SECTION A-A (SEE SHEET 49)
PROP. POND E SECTION B-B (SEE SHEET 49)
APPROX. POND E LIMIT OF CCR
PROP. POND E
SCALE: 1" = 100'
100 0 100 200
DRAWING TITLE
OVERALL PHASE 1 GRADING PLAN - POND E CLOSURE
PROJECT
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA
gai consultants
CLIENT
VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA
NO. DATE: DWN: CKS: APV: DESCRIPTION:
REVISION RECORD
ISSUING OFFICE: Richmond | 4198 Cox Road, Suite 114, Glen Allen, VA 23060
DRAWN BY: DOYLEMP
CHECKED BY: KONDEKW
APPROVED BY: KLAMUR
DWG TYPE:
SCALE: AS SHOWN
ISSUE DATE: 11/18/2015
SHEET NO.: 37 OF 55
GAI FILE NUMBER: C150132-00-000-C-D1-037
ALT./CLIENT DRAWING NUMBER:
GAI DRAWING NUMBER: 037
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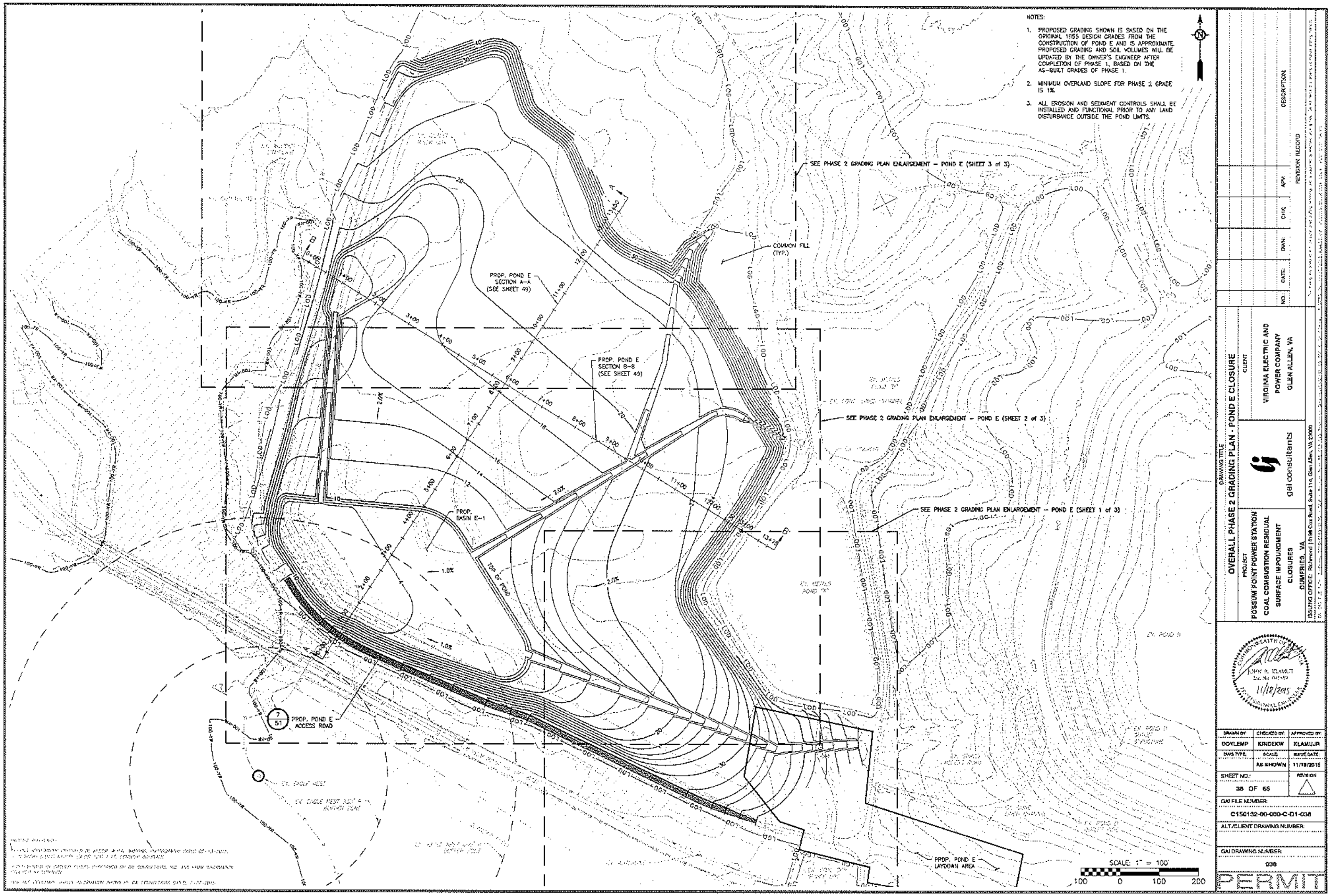
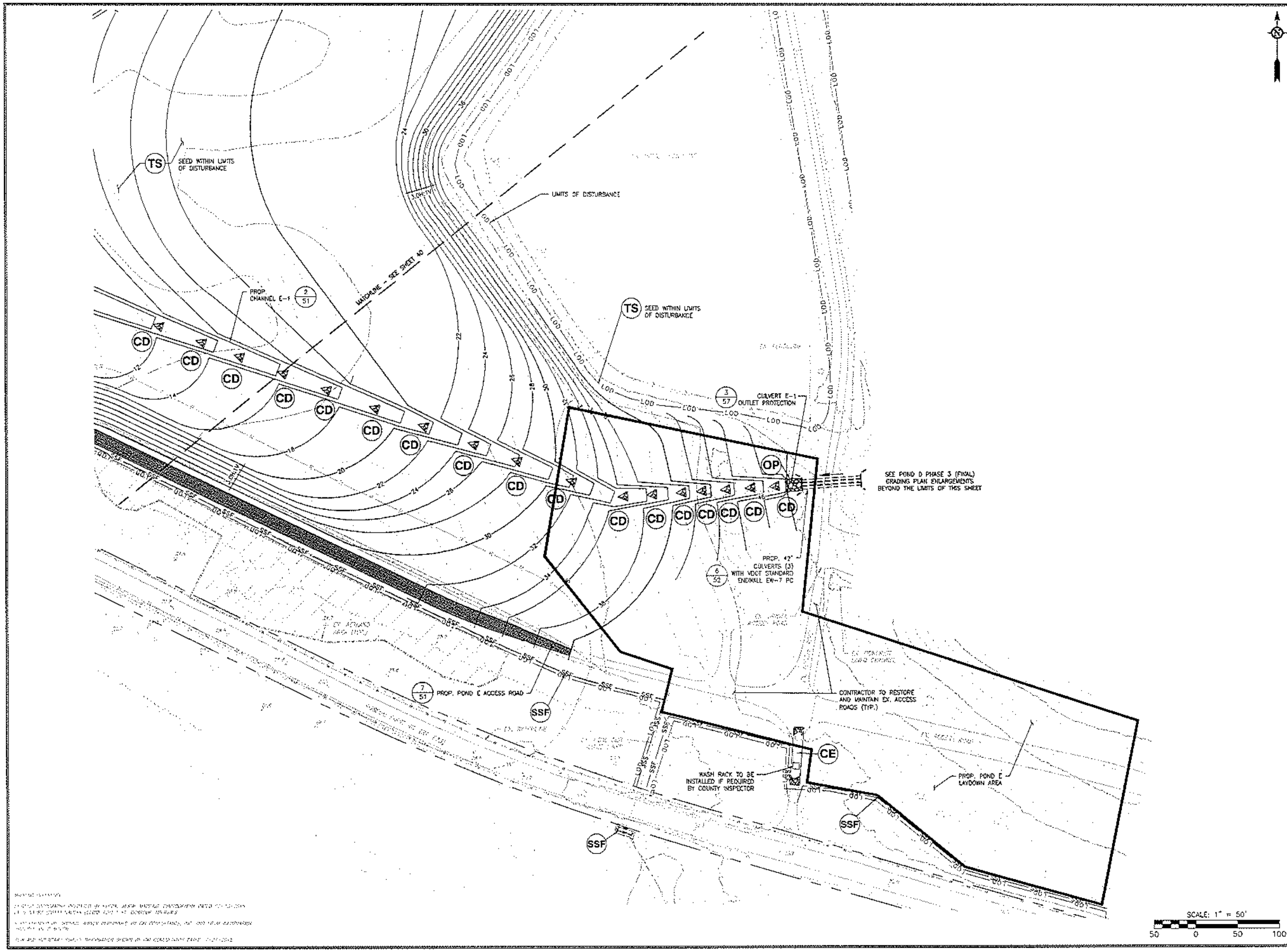

NOTES:
1. PROPOSED GRADING SHOWN IS BASED ON THE ORIGINAL 1955 DESIGN GRADES FROM THE CONSTRUCTION OF POND E AND IS APPROXIMATE. PROPOSED GRADING AND SOIL VOLUMES WILL BE UPDATED BY THE OWNER'S ENGINEER AFTER COMPLETION OF PHASE 1, BASED ON THE AS-BUILT GRADES OF PHASE 1.
2. MINIMUM OVERLAND SLOPE FOR PHASE 2 GRADE IS 1%.
3. ALL EROSION AND SEDIMENT CONTROLS SHALL BE INSTALLED AND FUNCTIONAL PRIOR TO ANY LAND DISTURBANCE OUTSIDE THE POND LIMITS.
SEE PHASE 2 GRADING PLAN ENLARGEMENT - POND E (SHEET 3 of 3)
SEE PHASE 2 GRADING PLAN ENLARGEMENT - POND E (SHEET 2 of 3)
SEE PHASE 2 GRADING PLAN ENLARGEMENT - POND E (SHEET 1 of 3)
COMMON FILL (TYP.)
PROP. POND E SECTION A-A (SEE SHEET 49)
PROP. POND E SECTION B-B (SEE SHEET 49)
PROP. BASIN E-1
TOP OF POND
PROP. POND E ACCESS ROAD
PROP. POND E LAYDOWN AREA
2.0%
1.0%
SCALE: 1" = 100'
100 0 100 200
DRAWING TITLE
OVERALL PHASE 2 GRADING PLAN - POND E CLOSURE
PROJECT
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA
gai consultants
CLIENT
VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA
ISSUING OFFICE: Richmond | 4198 Cox Road, Suite 114, Glen Allen, VA 23060
JOHN R. KLAMUT
Lic. No. 041459
11/18/2015
DRAWN BY: DOYLEMP
CHECKED BY: KINDEKW
APPROVED BY: KLAMUJR
DWG TYPE:
SCALE: AS SHOWN
ISSUE DATE: 11/18/2015
SHEET NO.: 38 OF 65
REVISION
GAI FILE NUMBER: C150132-00-000-C-D1-038
ALT./CLIENT DRAWING NUMBER:
GAI DRAWING NUMBER: 038
PERMIT
NO. DATE DWN. CHK. APV. DESCRIPTION
REVISION RECORD



DRAWING TITLE
PHASE 2 GRADING PLAN ENLARGEMENT - POND E CLOSURE (1 of 3)

PROJECT
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA

gai consultants

CLIENT
VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA

ISSUING OFFICE: Richmond | 4198 Cox Road, Suite 114, Glen Allen, VA 23060

NO.	DATE	DWN.	CHK.	APV.	DESCRIPTION

REVISION RECORD

JOHN R. KLAMUT
11/18/2015
PROFESSIONAL ENGINEER

DRAWN BY:	CHECKED BY:	APPROVED BY:
DOYLEMP	KINDEKW	KLAMUJR
DWG TYPE:	SCALE:	ISSUE DATE:
	AS SHOWN	11/18/2015

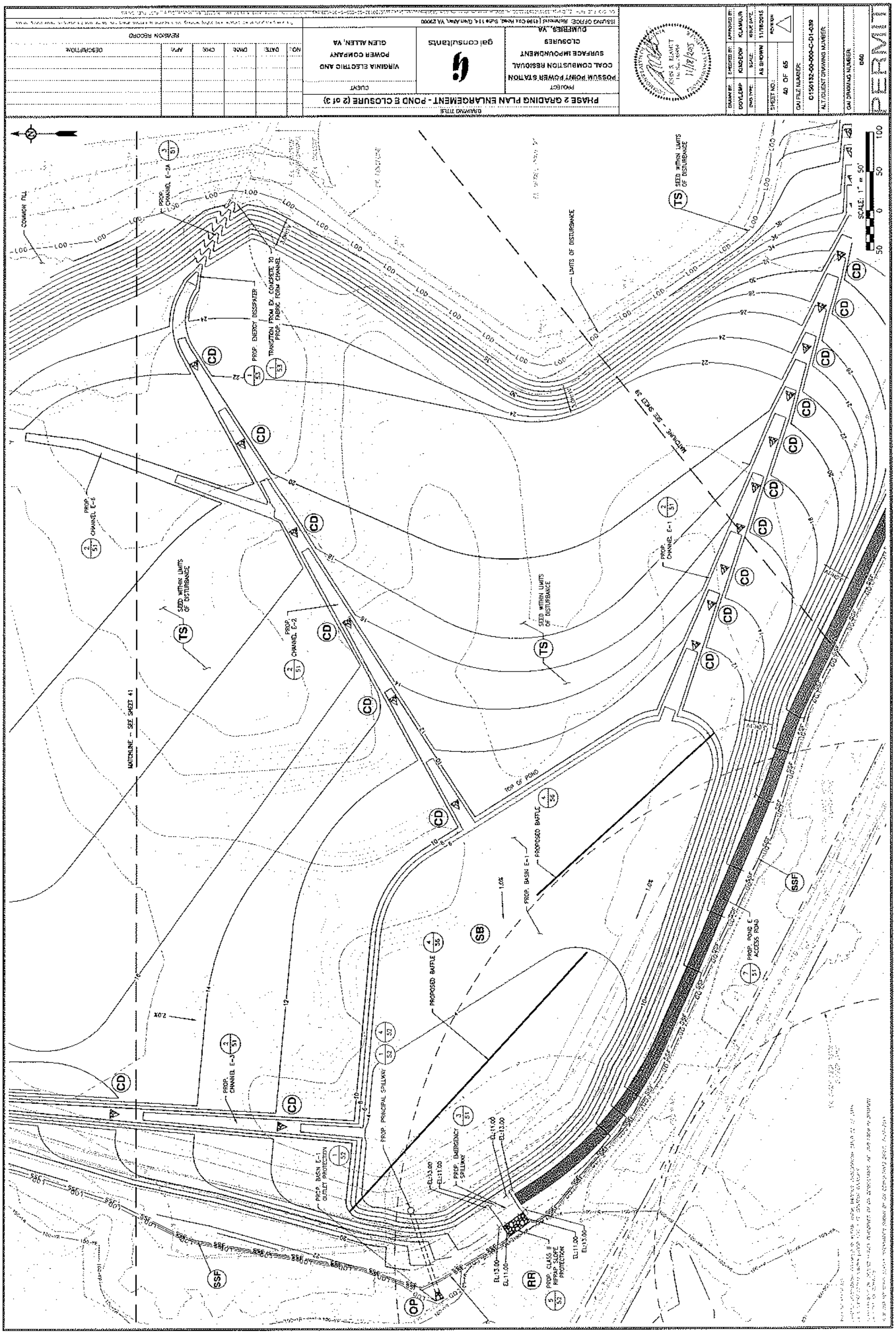
SHEET NO.: 39 OF 65
REVISION: △

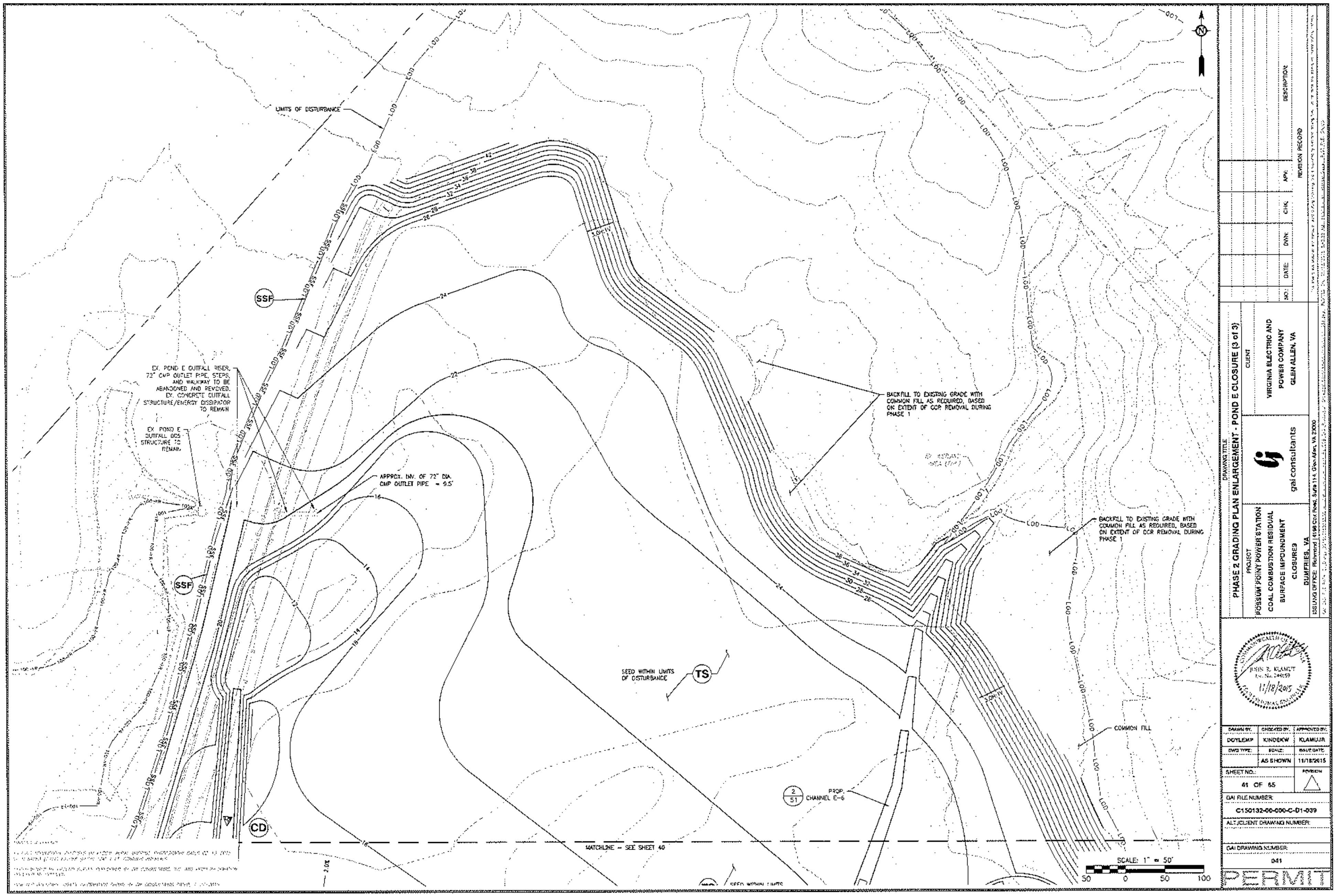
GAI FILE NUMBER: C150132-00-000-C-D1-039

ALT./CLIENT DRAWING NUMBER:

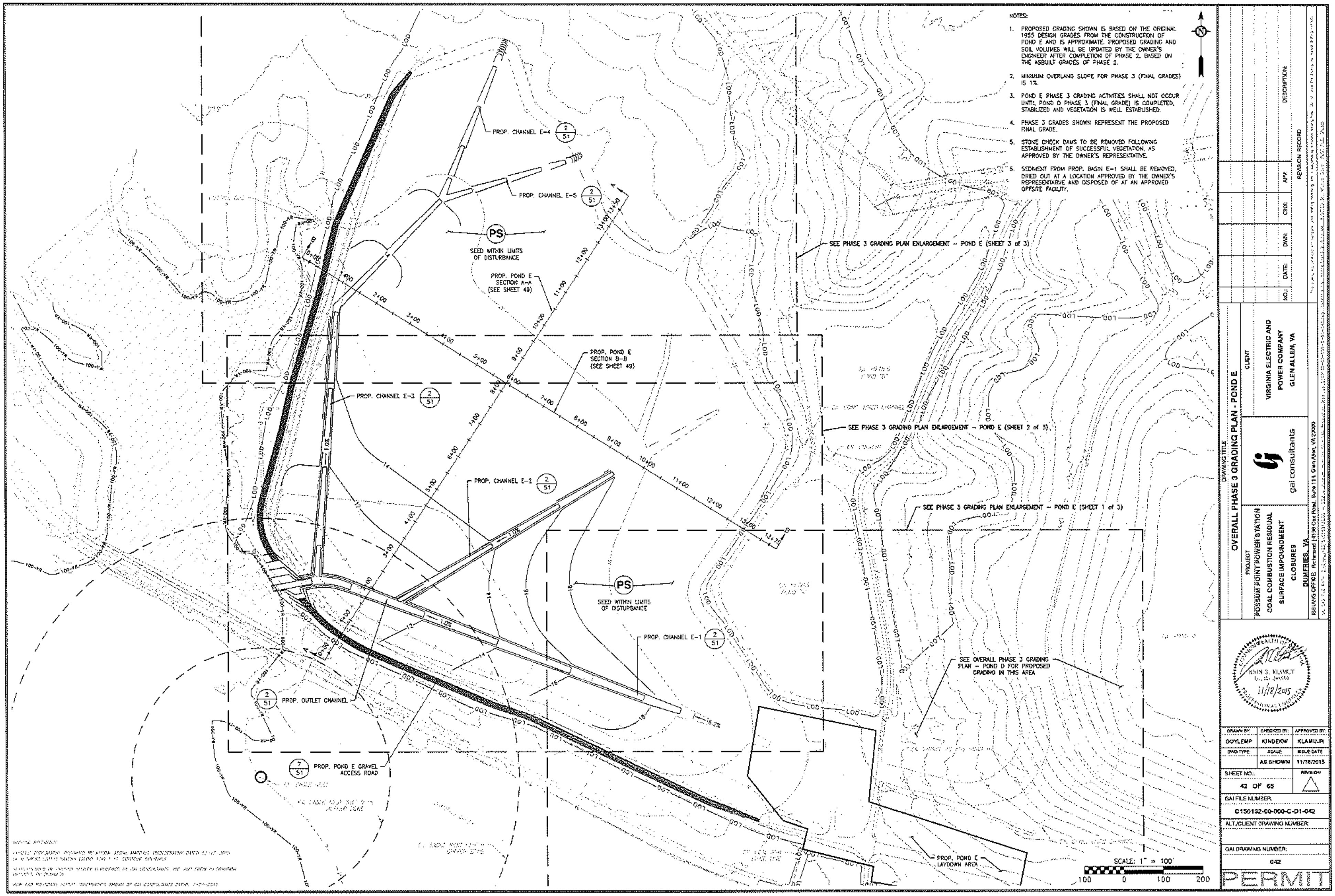
GAI DRAWING NUMBER: 039

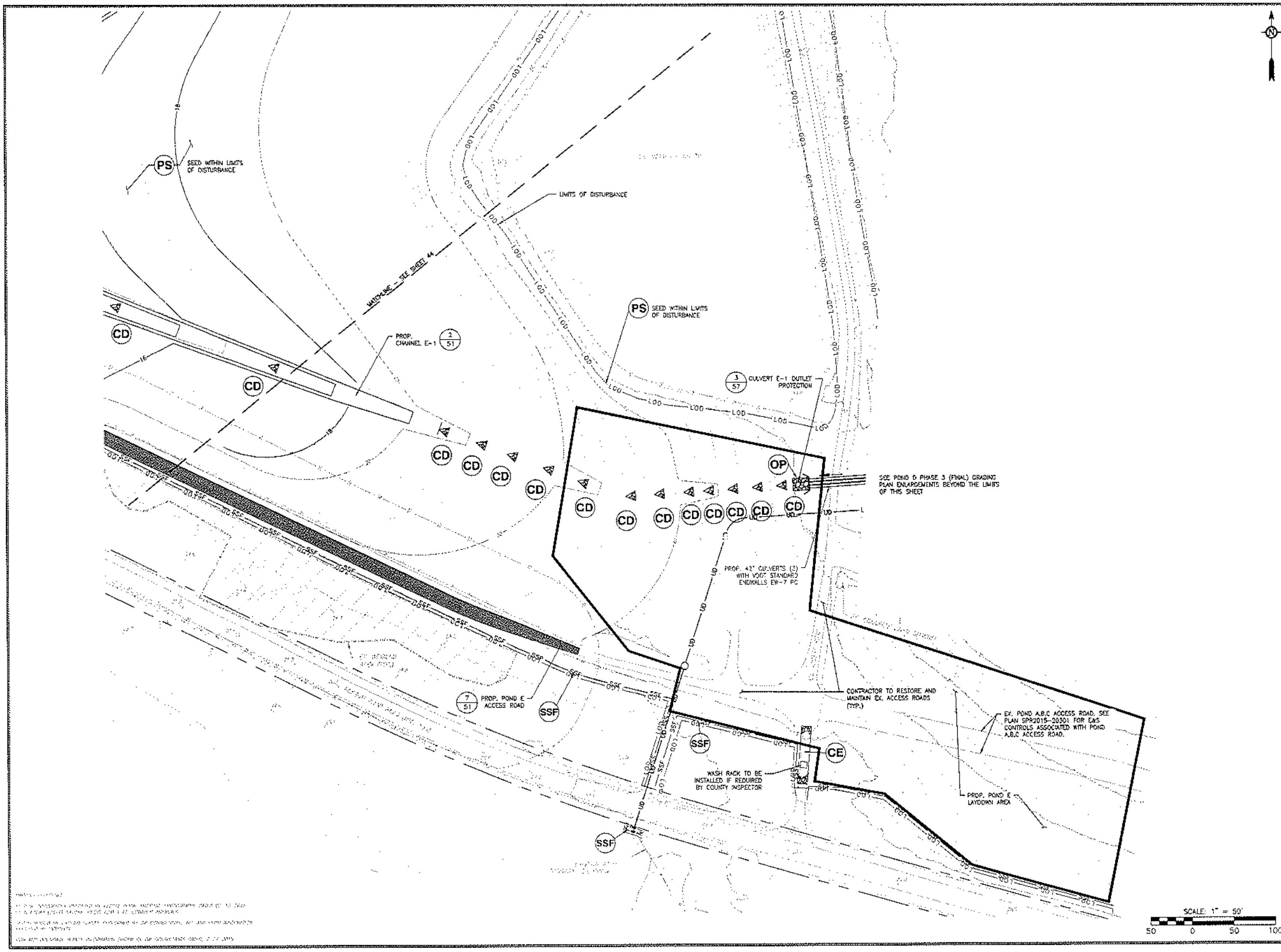
PERMIT


PHASE 2 GRADING PLAN ENLARGEMENT - POND E CLOSURE (2 of 3)
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA
VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA
gai consultants
40 OF 65
SCALE: 1" = 50'
MATCHLINE - SEE SHEET 41
MATCHLINE - SEE SHEET 39
PROP. CHANNEL E-1
PROP. CHANNEL E-2
PROP. CHANNEL E-3
PROP. CHANNEL E-6
PROP. BASIN E-1
PROPOSED BAFFLE
PROP. PRINCIPAL SPILLWAY
PROP. EMERGENCY SPILLWAY
PROP. ENERGY DISSIPATER
LIMITS OF DISTURBANCE
SEED WITHIN LIMITS OF DISTURBANCE
TOP OF POND
PROP. POND E ACCESS ROAD
COMMON FILL



LIMITS OF DISTURBANCE
SSF
EX. POND E OUTFALL RISER, 72" CMP OUTLET PIPE, STEPS, AND WALKWAY TO BE ABANDONED AND REMOVED. EX. CONCRETE OUTFALL STRUCTURE/ENERGY DISSIPATOR TO REMAIN
EX. POND E OUTFALL 005 STRUCTURE TO REMAIN
APPROX. INV. OF 72" DIA. CMP OUTLET PIPE = 9.5'
BACKFILL TO EXISTING GRADE WITH COMMON FILL AS REQUIRED, BASED ON EXTENT OF CCR REMOVAL DURING PHASE 1
SEED WITHIN LIMITS OF DISTURBANCE
TS
PROP. CHANNEL E-6
COMMON FILL
CD
MATCHLINE - SEE SHEET 40
SCALE: 1" = 50'
50 0 50 100
DRAWING TITLE
PHASE 2 GRADING PLAN ENLARGEMENT - POND E CLOSURE (3 of 3)
PROJECT
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL SURFACE IMPOUNDMENT CLOSURES
DUMFRIES, VA
CLIENT
VIRGINIA ELECTRIC AND POWER COMPANY
GLEN ALLEN, VA
gai consultants
JOHN R. KLAMUT
11/18/2015
DRAWN BY: DOYLEMP
CHECKED BY: KINDEKW
APPROVED BY: KLAMUJR
DWG TYPE:
SCALE: AS SHOWN
ISSUE DATE: 11/18/2015
SHEET NO.: 41 OF 65
REVISION
GAI FILE NUMBER: C150132-00-000-C-D1-039
ALT./CLIENT DRAWING NUMBER:
GAI DRAWING NUMBER: 041
NO. DATE DWN. CHK. APV. DESCRIPTION
REVISION RECORD
PERMIT


NOTES:
1. PROPOSED GRADING SHOWN IS BASED ON THE ORIGINAL 1955 DESIGN GRADES FROM THE CONSTRUCTION OF POND E AND IS APPROXIMATE. PROPOSED GRADING AND SOIL VOLUMES WILL BE UPDATED BY THE OWNER'S ENGINEER AFTER COMPLETION OF PHASE 2. BASED ON THE ASBUILT GRADES OF PHASE 2.
2. MINIMUM OVERLAND SLOPE FOR PHASE 3 (FINAL GRADES) IS 1%.
3. POND E PHASE 3 GRADING ACTIVITIES SHALL NOT OCCUR UNTIL POND D PHASE 3 (FINAL GRADE) IS COMPLETED, STABILIZED AND VEGETATION IS WELL ESTABLISHED.
4. PHASE 3 GRADES SHOWN REPRESENT THE PROPOSED FINAL GRADE.
5. STONE CHECK DAMS TO BE REMOVED FOLLOWING ESTABLISHMENT OF SUCCESSFUL VEGETATION, AS APPROVED BY THE OWNER'S REPRESENTATIVE.
5. SEDIMENT FROM PROP. BASIN E-1 SHALL BE REMOVED, DRIED OUT AT A LOCATION APPROVED BY THE OWNER'S REPRESENTATIVE AND DISPOSED OF AT AN APPROVED OFFSITE FACILITY.
PROP. CHANNEL E-4
PROP. CHANNEL E-5
PROP. CHANNEL E-3
PROP. CHANNEL E-2
PROP. CHANNEL E-1
PS
SEED WITHIN LIMITS OF DISTURBANCE
PROP. POND E SECTION A-A (SEE SHEET 49)
PROP. POND E SECTION B-B (SEE SHEET 49)
SEE PHASE 3 GRADING PLAN ENLARGEMENT – POND E (SHEET 3 of 3)
SEE PHASE 3 GRADING PLAN ENLARGEMENT – POND E (SHEET 2 of 3)
SEE PHASE 3 GRADING PLAN ENLARGEMENT – POND E (SHEET 1 of 3)
SEE OVERALL PHASE 3 GRADING PLAN – POND D FOR PROPOSED GRADING IN THIS AREA
PROP. OUTLET CHANNEL
PROP. POND E GRAVEL ACCESS ROAD
PROP. POND E LAYDOWN AREA
SCALE: 1" = 100'
100 0 100 200
DRAWING TITLE
OVERALL PHASE 3 GRADING PLAN - POND E
PROJECT
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA
gai consultants
CLIENT
VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA
NO. DATE DWN CHK APP DESCRIPTION
REVISION RECORD
11/18/2015
DRAWN BY: DOYLEMP
CHECKED BY: KINDEKW
APPROVED BY: KLAMUJR
DWG TYPE:
SCALE: AS SHOWN
ISSUE DATE: 11/18/2015
SHEET NO.: 42 OF 65
REVISION
GAI FILE NUMBER: C150132-00-000-C-D1-042
ALT./CLIENT DRAWING NUMBER:
GAI DRAWING NUMBER: 042
PERMIT



DRAWING TITLE
PHASE 3 GRADING PLAN ENLARGEMENT - POND E (1 of 3)

PROJECT
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA

CLIENT
VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA

gai consultants

ISSUING OFFICE: Richmond | 4198 Cox Road, Suite 114, Glen Allen, VA 23060

NO.	DATE	DWN	CHK	APV	DESCRIPTION

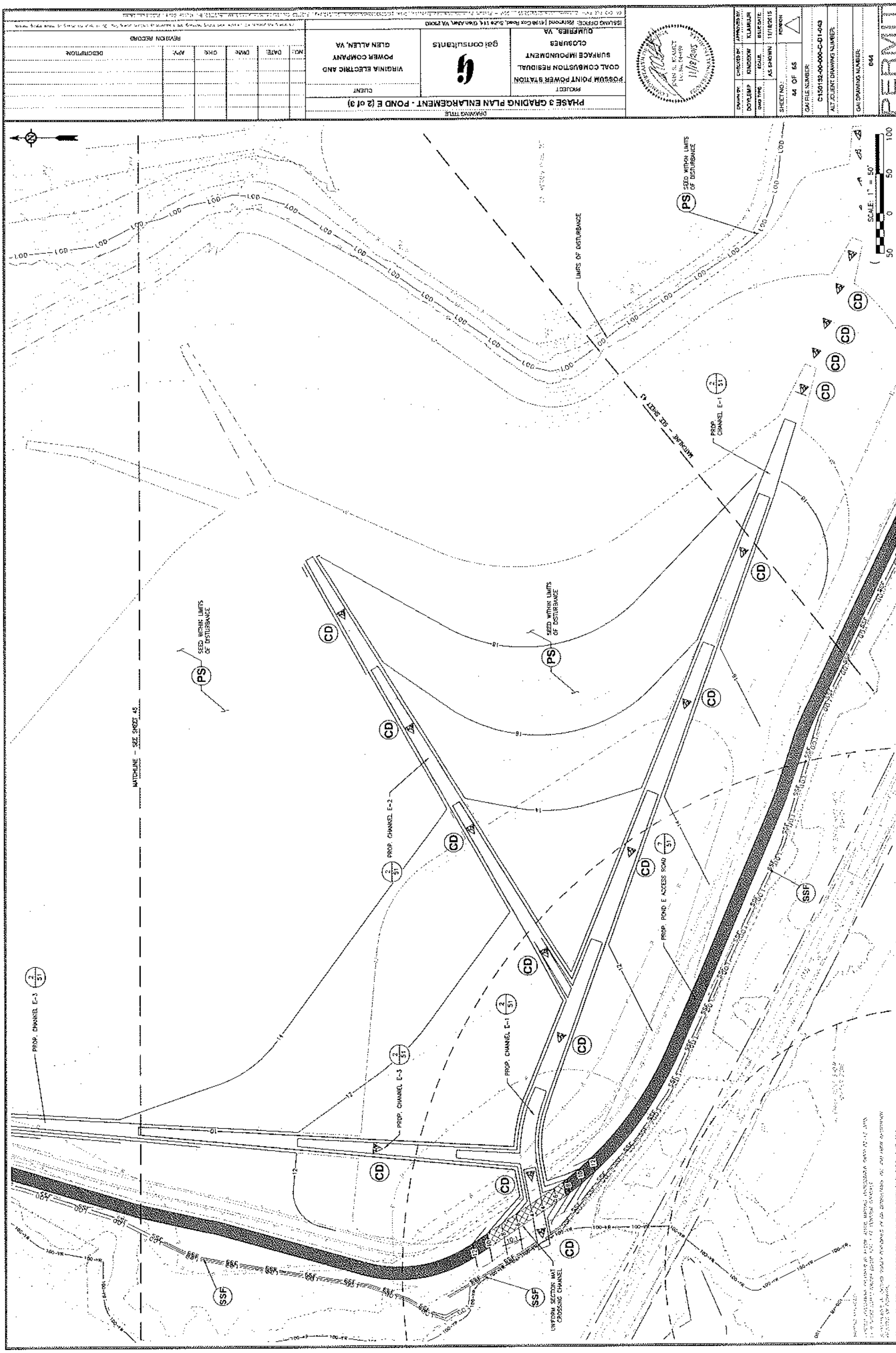
REVISION RECORD

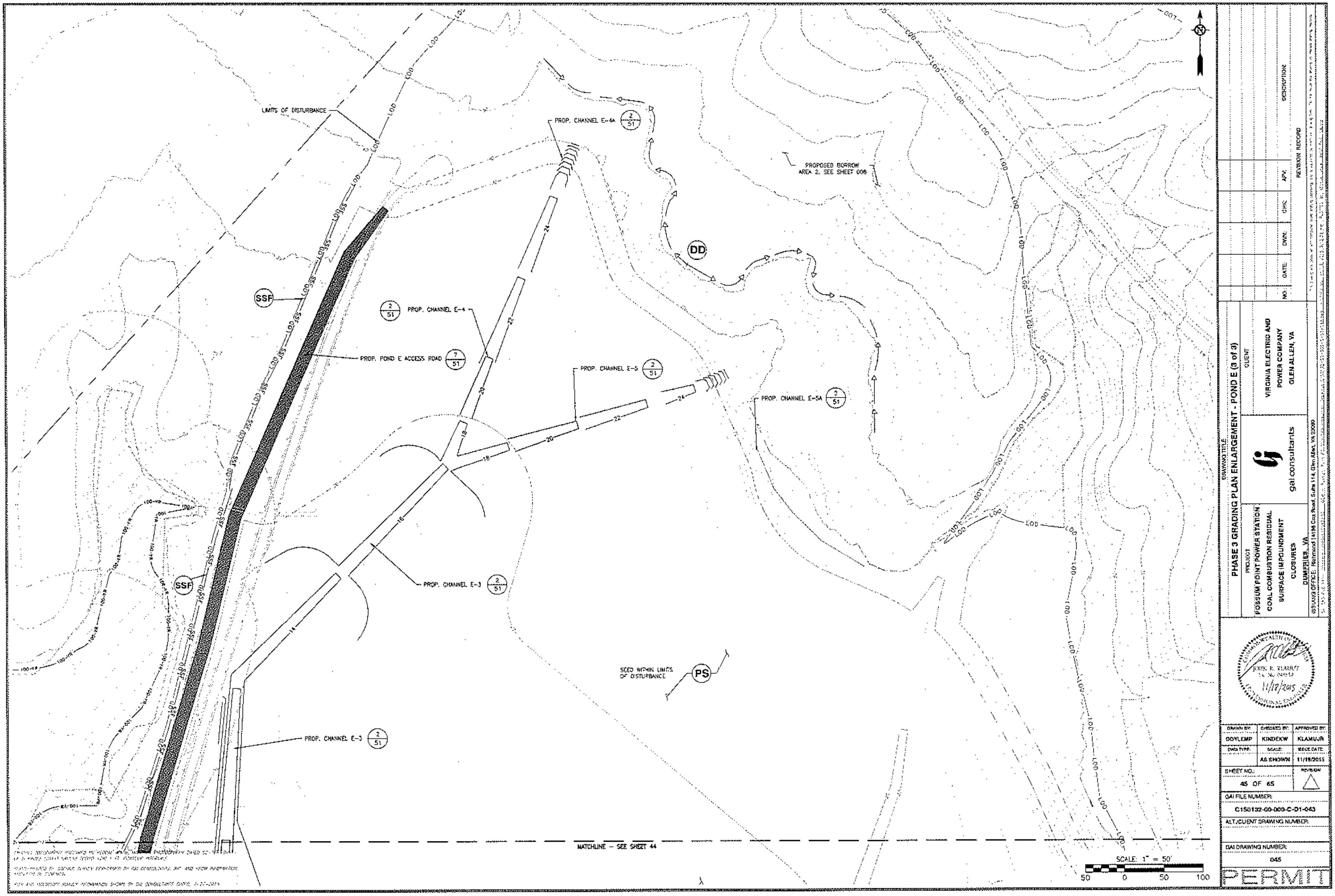
JOHN R. KLAMUT
Lic. No. 24857
11/18/2015

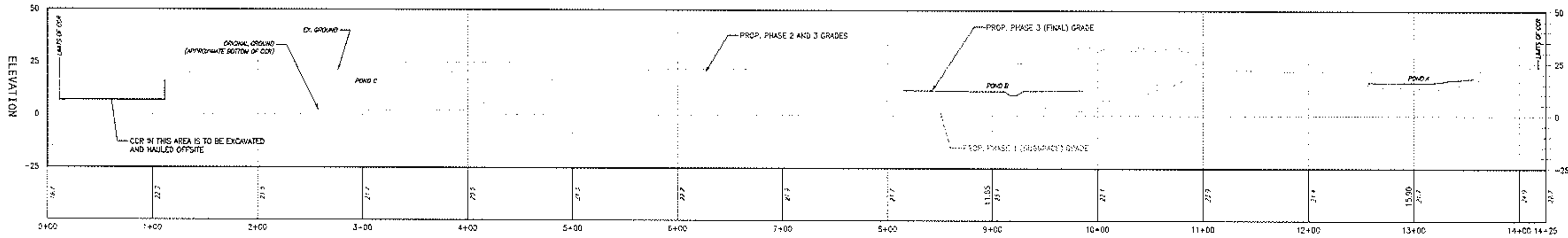
DRAWN BY:	CHECKED BY:	APPROVED BY:
DOYLEMP	KINDEXW	KLAMUJR
DWG TYPE:	SCALE:	ISSUE DATE:
	AS SHOWN	11/18/2015

SHEET NO.: 43 OF 65
REVISION: △
GAI FILE NUMBER: C150132-00-000-C-D1-043
ALT./CLIENT DRAWING NUMBER:
GAI DRAWING NUMBER: 043

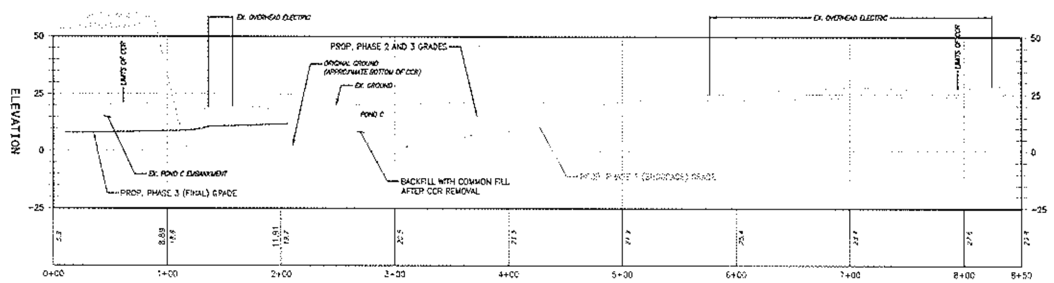
PERMIT


PHASE 3 GRADING PLAN ENLARGEMENT - POND E (2 of 3)
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA
VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA
gai consultants
44 OF 65
PERMIT
MATCHLINE - SEE SHEET 45
LIMITS OF DISTURBANCE
SEED WITHIN LIMITS OF DISTURBANCE
PROP. CHANNEL E-1
PROP. CHANNEL E-2
PROP. CHANNEL E-3
PROP. POND E ACCESS ROAD
UNIFORM SECTION MAT CROSSING CHANNEL
SCALE: 1" = 50'

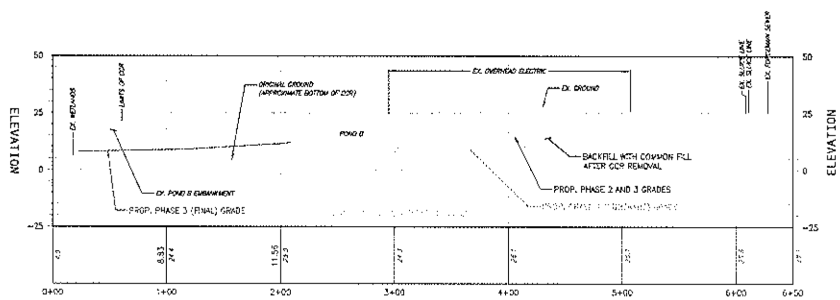

LIMITS OF DISTURBANCE
PROP. CHANNEL E-4A 2/51
PROPOSED BORROW AREA 2. SEE SHEET 006
DD
SSF
PROP. CHANNEL E-4 2/51
PROP. POND E ACCESS ROAD 7/51
PROP. CHANNEL E-5 2/51
PROP. CHANNEL E-5A 2/51
PROP. CHANNEL E-3 2/51
SEED WITHIN LIMITS OF DISTURBANCE
PS
MATCHLINE - SEE SHEET 44
SCALE: 1" = 50'
50 0 50 100
DRAWING TITLE
PHASE 3 GRADING PLAN ENLARGEMENT - POND E (3 of 3)
PROJECT
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL SURFACE IMPOUNDMENT CLOSURES
DUMFRIES, VA
gai consultants
CLIENT
VIRGINIA ELECTRIC AND POWER COMPANY
GLEN ALLEN, VA
NO. DATE: DWN: CHK: APV: DESCRIPTION
REVISION RECORD
DRAWN BY: DOYLEMP
CHECKED BY: KINDEKW
APPROVED BY: KLAMUJR
DWG TYPE:
SCALE: AS SHOWN
ISSUE DATE: 11/18/2015
SHEET NO.: 45 OF 65
REVISION
GAI FILE NUMBER: C150132-00-000-C-D1-043
ALT./CLIENT DRAWING NUMBER:
GAI DRAWING NUMBER: 045
PERMIT



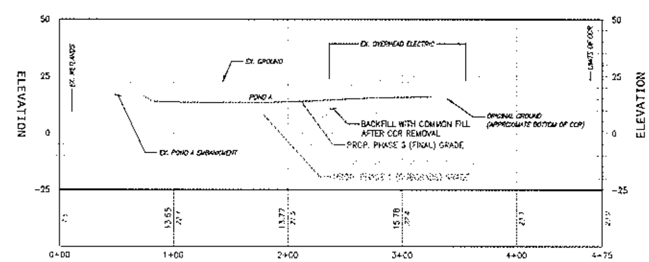
POND ABC SECTION A-A
SCALE: 1"=50' HORIZ.
1"=25' VERT.



POND C SECTION B-B
SCALE: 1"=50' HORIZ.
1"=25' VERT.



POND B SECTION C-C
SCALE: 1"=50' HORIZ.
1"=25' VERT.



POND A SECTION D-D
SCALE: 1"=50' HORIZ.
1"=25' VERT.

NOTES:
1. THIS DRAWING DEPICTS THE SITE CROSS SECTIONS AS IDENTIFIED ON THE SITE PLANS. REFER TO THE SITE PLANS FOR ADDITIONAL INFORMATION.
2. THE CROSS SECTIONS FOR POND A,B,C AND POND E DEPICT APPROXIMATE SURFACES OF EXISTING GROUND, ORIGINAL GROUND (BOTTOM OF CCR), PROPOSED PHASE 1 GRADING, PROPOSED PHASE 2 GRADING, AND PROPOSED PHASE 3 (FINAL) GRADING.
3. EARTHWORK SHALL BE PERFORMED IN ACCORDANCE WITH THE DRAWINGS, TECHNICAL SPECIFICATIONS, AND CQC PLAN IN ORDER TO DEVELOP THE PROPOSED GRADES SHOWN ON THE SITE PLANS AND CROSS SECTIONS.
4. PLACE COMMON FILL BETWEEN PHASE 1 AND PHASE 2/3 GRADES FOR POND A,B,C AND E.
5. ORIGINAL GROUND IS PROVIDED FOR GENERAL INFORMATION ONLY. IT IS BASED ON DESIGN DRAWINGS AND IS APPROXIMATE. ORIGINAL GROUND DOES NOT ACCOUNT FOR BORROW AREAS AND OTHER FEATURES BEHIND THE DAMS THAT MAY SIGNIFICANTLY IMPACT THE APPROXIMATE GRADE.
6. LOCATIONS OF UTILITIES AND OTHER SITE FEATURES ARE APPROXIMATE AND SHOULD BE FIELD VERIFIED BY THE CONTRACTOR. CLEARANCES OF OVERHEAD ELECTRIC UTILITIES ARE NOT SHOWN. THE CONTRACTOR SHOULD VERIFY THE OVERHEAD CLEARANCES AND USE CAUTION WHEN PERFORMING WORK IN THESE AREAS.
7. THE PROPOSED PHASE 1 GRADES DO NOT PRECISELY LINE UP WITH THE ORIGINAL GROUND GRADES, AS THE GRADES ARE APPROXIMATE. CONTRACTOR AND QC TEAM SHALL VERIFY THAT ALL CCR IN POND A,B,C AND E ARE REMOVED PRIOR TO PROCEEDING WITH PHASE 2.

SCALE: 1" = 50'
50 0 50 100

DRAWING TITLE
SITE CROSS SECTIONS (SHEET 1 OF 4)

PROJECT
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA

gai consultants

CLIENT
VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA

ISSUING OFFICE: Richmond | 4198 Cox Road, Suite 114, Glen Allen, VA 23060

NO.	DATE	DWN.	CHK.	APV.	DESCRIPTION

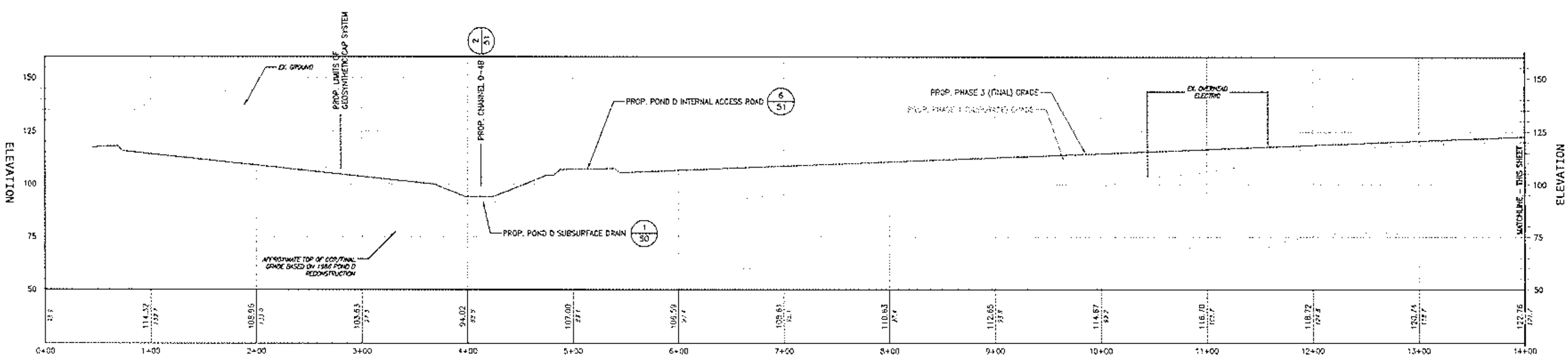
REVISION RECORD

JOHN R. KLAMUT
Lic. No. 28884
11/18/2015

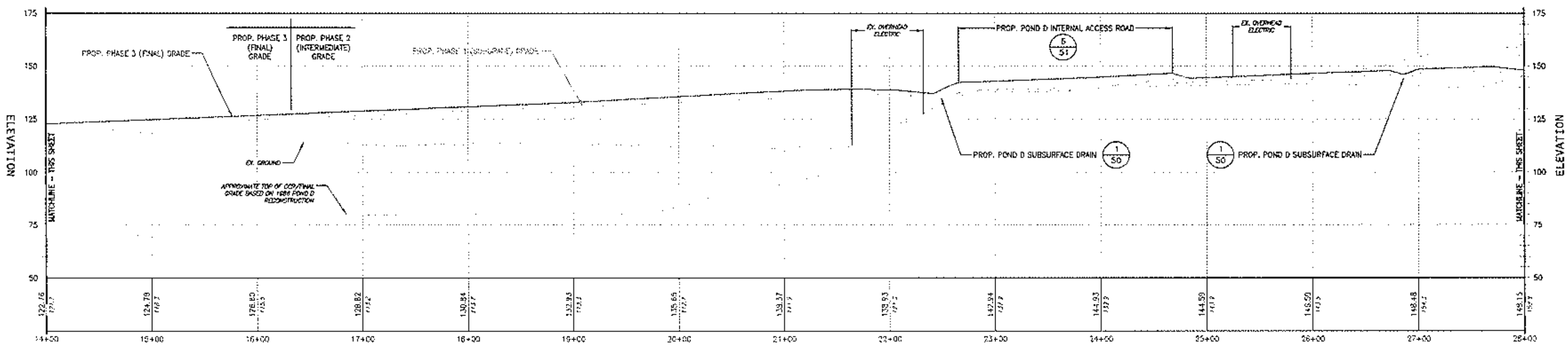
DRAWN BY:	CHECKED BY:	APPROVED BY:
BRIARS	KINDEKW	KLAMUJR
DWG TYPE:	SCALE:	ISSUE DATE:
	AS SHOWN	11/18/2015

SHEET NO.: 46 OF 85
REVISION:
GAI FILE NUMBER: C150132-00-000-C-D1-046
ALT./CLIENT DRAWING NUMBER:
GAI DRAWING NUMBER: 046

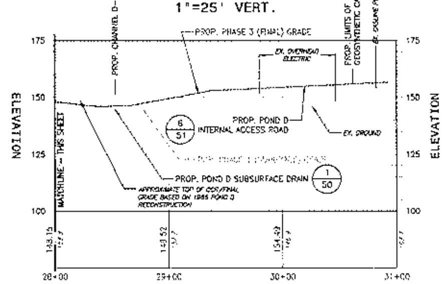
PERMIT



POND D SECTION A-A
SCALE: 1"=50' HORIZ.
1"=25' VERT.



POND D SECTION A-A
SCALE: 1"=50' HORIZ.
1"=25' VERT.



POND D SECTION A-A
SCALE: 1"=50' HORIZ.
1"=25' VERT.

NOTES:
1. THIS DRAWING DEPICTS THE SITE CROSS SECTIONS AS IDENTIFIED ON THE SITE PLANS. REFER TO THE SITE PLANS FOR ADDITIONAL INFORMATION.
2. THE CROSS SECTIONS FOR POND D DEPICT APPROXIMATE SURFACES OF EXISTING GROUND, ORIGINAL GROUND (BOTTOM OF CCR), PROPOSED PREPARED SUBGRADE SURFACE AND PROPOSED FINAL GRADE.
3. EARTHWORK SHALL BE PERFORMED IN ACCORDANCE WITH THE DRAWINGS, TECHNICAL SPECIFICATIONS, AND CQC PLAN IN ORDER TO DEVELOP THE PROPOSED GRADES SHOWN ON THE SITE PLANS AND CROSS SECTIONS.
4. PLACE SUBGRADE FILL (INCLUDES CCR) BETWEEN SUBGRADE AND EXISTING GRADE IN POND D, WITHIN GEOSYNTHETIC CAP SYSTEM LIMITS. COMMON FILL SHALL BE PLACED OUTSIDE THE LIMITS OF THE GEOSYNTHETIC CAP SYSTEM TO MEET PROPOSED FINAL GRADE, UNLESS OTHERWISE NOTED.
5. 1986 GRADE IS PROVIDED FOR GENERAL INFORMATION ONLY. IT IS BASED ON DESIGN DRAWINGS AND IS APPROXIMATE. IT DOES NOT ACCOUNT FOR BORROW AREAS AND OTHER FEATURES BEHIND THE DAMS THAT MAY SIGNIFICANTLY IMPACT THE APPROXIMATE GRADE.
6. LOCATIONS OF UTILITIES AND OTHER SITE FEATURES ARE APPROXIMATE AND SHOULD BE FIELD VERIFIED BY THE CONTRACTOR. CLEARANCES OF OVERHEAD ELECTRIC UTILITIES ARE NOT SHOWN. THE CONTRACTOR SHOULD VERIFY THE OVERHEAD CLEARANCES AND USE CAUTION WHEN PERFORMING WORK IN THESE AREAS.
7. GEOSYNTHETIC LAYERS ASSOCIATED WITH THE POND D CAP SHALL BE INSTALLED IN ACCORDANCE WITH THE DRAWINGS, TECHNICAL SPECIFICATIONS, AND CQC PLAN IN ORDER TO DEVELOP THE PROPOSED GRADES AND LAYERS PRESENTED ON THE SITE PLANS, DETAILS, AND CROSS SECTIONS.

SCALE: 1" = 50'
50 0 50 100

NO.	DATE	DWN.	CHK.	APP.	DESCRIPTION

REVISION RECORD

DRAWING TITLE
SITE CROSS SECTIONS (SHEET 2 OF 4)

PROJECT
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA

gai consultants

CLIENT
VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA

ISSUING OFFICE: Richmond | 4198 Cox Road, Suite 114, Glen Allen, VA 23060

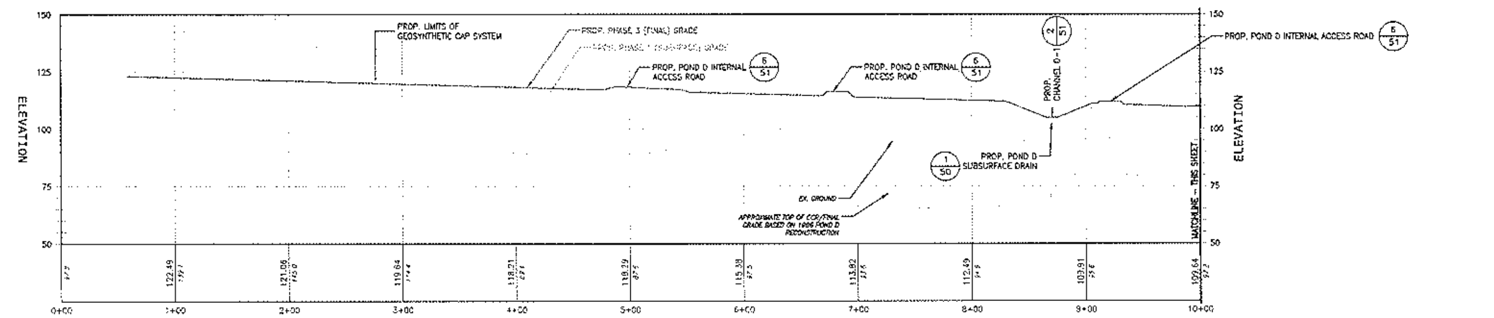
JOHN R. KLAMUT
11/18/2015

DRAWN BY:	CHECKED BY:	APPROVED BY:
BRIARS	KINDEKW	KLAMUJR
DWG TYPE:	SCALE:	ISSUE DATE:
	AS SHOWN	11/18/2015

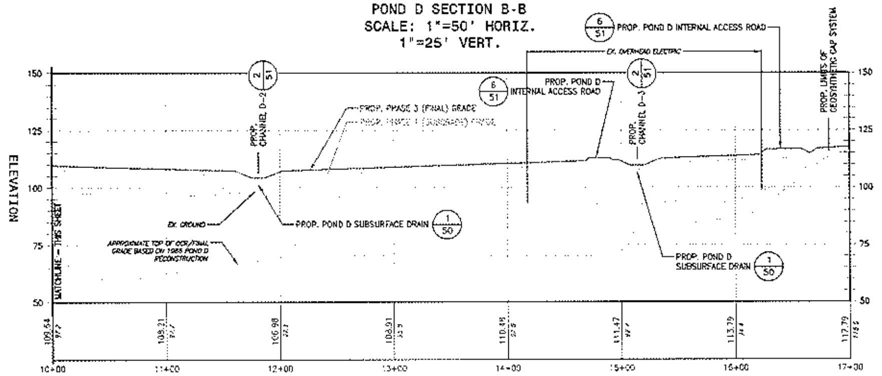
SHEET NO.: 47 OF 65
REVISION

GAI FILE NUMBER: D150132-00-000-C-D1-046
ALT./CLIENT DRAWING NUMBER:
GAI DRAWING NUMBER: 047

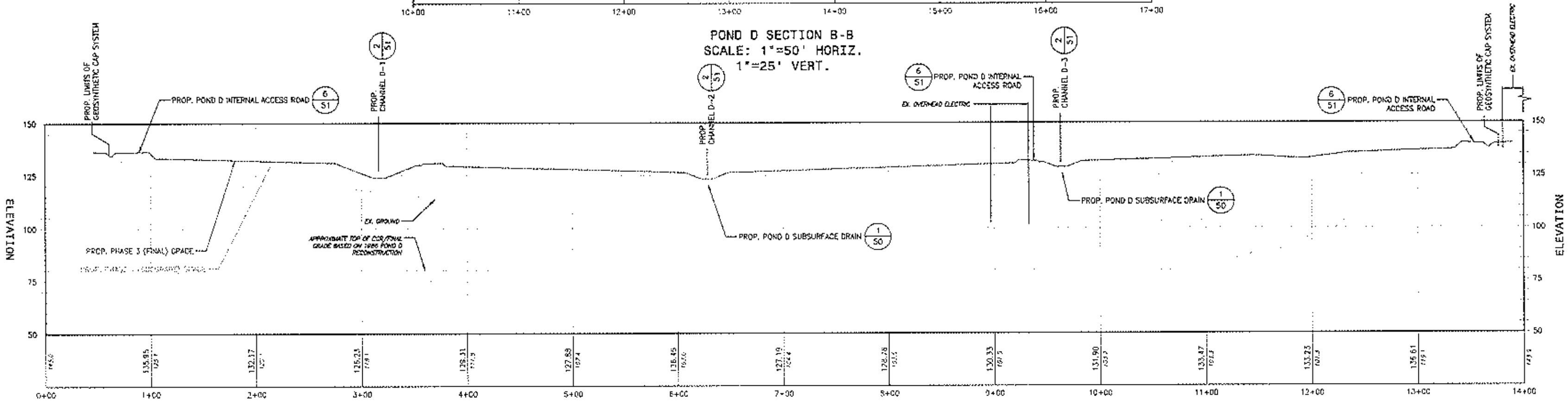
PERMIT



POND D SECTION B-B
SCALE: 1"=50' HORIZ.
1"=25' VERT.



POND D SECTION B-B
SCALE: 1"=50' HORIZ.
1"=25' VERT.



POND D SECTION C-C
SCALE: 1"=50' HORIZ.
1"=25' VERT.

NOTES:
1. THIS DRAWING DEPICTS THE SITE CROSS SECTIONS AS IDENTIFIED ON THE SITE PLANS. REFER TO THE SITE PLANS FOR ADDITIONAL INFORMATION.
2. THE CROSS SECTIONS FOR POND D DEPICT APPROXIMATE SURFACES OF EXISTING GROUND, ORIGINAL GROUND (BOTTOM OF CCR), PROPOSED PREPARED SUBGRADE SURFACE AND PROPOSED FINAL GRADE.
3. EARTHWORK SHALL BE PERFORMED IN ACCORDANCE WITH THE DRAWINGS, TECHNICAL SPECIFICATIONS, AND CQC PLAN IN ORDER TO DEVELOP THE PROPOSED GRADES SHOWN ON THE SITE PLANS AND CROSS SECTIONS.
4. PLACE SUBGRADE FILL (INCLUDES CCR) BETWEEN SUBGRADE AND EXISTING GRADE IN POND D, WITHIN GEOSYNTHETIC CAP SYSTEM LIMITS. COMMON FILL SHALL BE PLACED OUTSIDE THE LIMITS OF THE GEOSYNTHETIC CAP SYSTEM TO MEET PROPOSED FINAL GRADE, UNLESS OTHERWISE NOTED.
5. 1986 GRADE IS PROVIDED FOR GENERAL INFORMATION ONLY, IT IS BASED ON DESIGN DRAWINGS AND IS APPROXIMATE. IT DOES NOT ACCOUNT FOR BORROW AREAS AND OTHER FEATURES BEHIND THE DAMS THAT MAY SIGNIFICANTLY IMPACT THE APPROXIMATE GRADE.
6. LOCATIONS OF UTILITIES AND OTHER SITE FEATURES ARE APPROXIMATE AND SHOULD BE FIELD VERIFIED BY THE CONTRACTOR. CLEARANCES OF OVERHEAD ELECTRIC UTILITIES ARE NOT SHOWN. THE CONTRACTOR SHOULD VERIFY THE OVERHEAD CLEARANCES AND USE CAUTION WHEN PERFORMING WORK IN THESE AREAS.
7. GEOSYNTHETIC LAYERS ASSOCIATED WITH THE POND D CAP SHALL BE INSTALLED IN ACCORDANCE WITH THE DRAWINGS, TECHNICAL SPECIFICATIONS, AND CQC PLAN IN ORDER TO DEVELOP THE PROPOSED GRADES AND LAYERS PRESENTED ON THE SITE PLANS, DETAILS, AND CROSS SECTIONS.

SCALE: 1" = 50'
50 0 50 100

DRAWING TITLE: SITE CROSS SECTIONS (SHEET 3 OF 4)

PROJECT: POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA

gai consultants

CLIENT: VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA

ISSUING OFFICE: Richmond | 4198 Cox Road, Suite 114, Glen Allen, VA 23060

NO.	DATE	DWN.	CHK.	APV.	DESCRIPTION

REVISION RECORD

JOHN R. KLAMUT
11/18/2015

DRAWN BY:	CHECKED BY:	APPROVED BY:
BRIARS	KNDEXW	KLAMUJR
DWG TYPE:	SCALE: AS SHOWN	ISSUE DATE: 11/18/2015

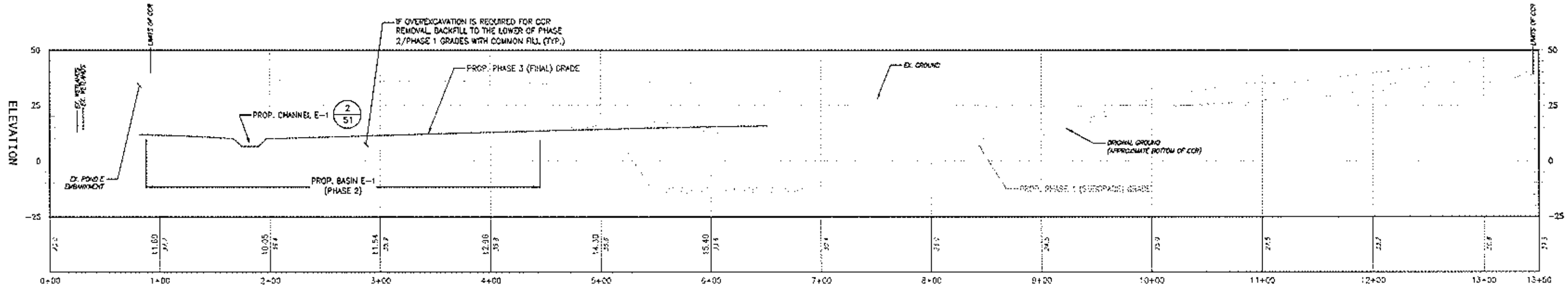
SHEET NO.: 48 OF 65
REVISION: △

GAI FILE NUMBER: C150132-00-000-C-D1-048

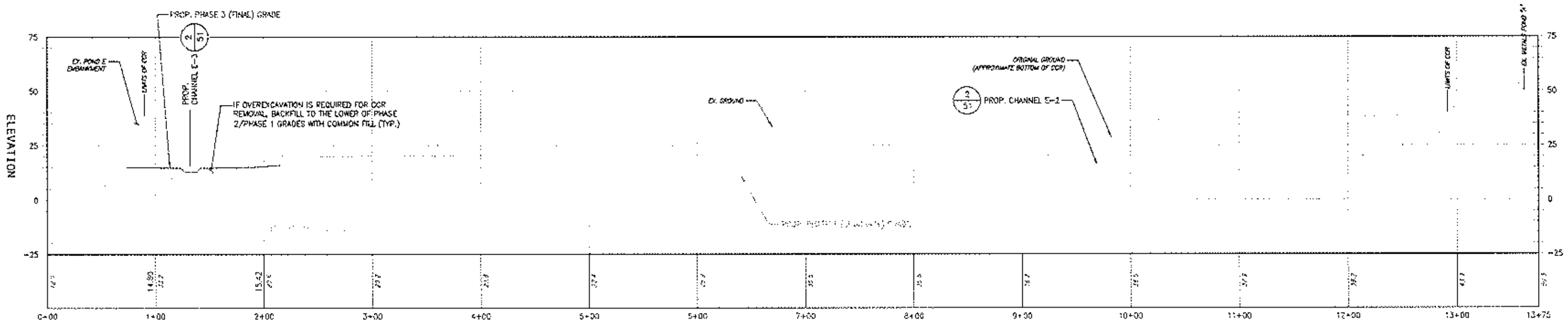
ALT./CLIENT DRAWING NUMBER:

GAI DRAWING NUMBER: 048

PERMIT



POND E SECTION A-A
SCALE: 1"=50' HORIZ.
1"=25' VERT.



POND E SECTION B-B
SCALE: 1"=50' HORIZ.
1"=25' VERT.

NOTES:
1. THIS DRAWING DEPICTS THE SITE CROSS SECTIONS AS IDENTIFIED ON THE SITE PLANS. REFER TO THE SITE PLANS FOR ADDITIONAL INFORMATION.
2. THE CROSS SECTIONS FOR POND A,B,C AND POND E DEPICT APPROXIMATE SURFACES OF EXISTING GROUND, ORIGINAL GROUND (BOTTOM OF CCR), PROPOSED PHASE 1 GRADING, PROPOSED PHASE 2 GRADING, AND PROPOSED PHASE 3 (FINAL) GRADING.
3. EARTHWORK SHALL BE PERFORMED IN ACCORDANCE WITH THE DRAWINGS, TECHNICAL SPECIFICATIONS, AND CQC PLAN IN ORDER TO DEVELOP THE PROPOSED GRADES SHOWN ON THE SITE PLANS AND CROSS SECTIONS.
4. PLACE COMMON FILL BETWEEN PHASE 1 AND PHASE 2/3 GRADES FOR POND A,B,C AND E.
5. ORIGINAL GROUND IS PROVIDED FOR GENERAL INFORMATION ONLY. IT IS BASED ON DESIGN DRAWINGS AND IS APPROXIMATE. ORIGINAL GROUND DOES NOT ACCOUNT FOR BORROW AREAS AND OTHER FEATURES BEHIND THE DAMS THAT MAY SIGNIFICANTLY IMPACT THE APPROXIMATE GRADE.
6. LOCATIONS OF UTILITIES AND OTHER SITE FEATURES ARE APPROXIMATE AND SHOULD BE FIELD VERIFIED BY THE CONTRACTOR. CLEARANCES OF OVERHEAD ELECTRIC UTILITIES ARE NOT SHOWN. THE CONTRACTOR SHOULD VERIFY THE OVERHEAD CLEARANCES AND USE CAUTION WHEN PERFORMING WORK IN THESE AREAS.
7. THE PROPOSED PHASE 1 GRADES DO NOT PRECISELY LINE UP WITH THE ORIGINAL GROUND GRADES, AS THE GRADES ARE APPROXIMATE. CONTRACTOR AND QC TEAM SHALL VERIFY THAT ALL ASH/CCR IN POND A,B,C AND E ARE REMOVED PRIOR TO PROCEEDING WITH PHASE 2.

SCALE: 1" = 50'
50 0 50 100

NO.	DATE	DWN.	CHK.	APV.	DESCRIPTION

REVISION RECORD

DRAWING TITLE
SITE CROSS SECTIONS (SHEET 4 OF 4)

PROJECT
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA

CLIENT
VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA

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ISSUING OFFICE: Richmond | 4198 Cox Road, Suite 114, Glen Allen, VA 23060

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Lic. No. 24549
11/18/2015

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BRIARS	KINDEKW	KLAMUJR
DWG TYPE:	SCALE:	ISSUE DATE:
	AS SHOWN	11/18/2015

SHEET NO.: 49 OF 65
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GAI FILE NUMBER: C150132-00-000-C-D1-046

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GAI DRAWING NUMBER: 049

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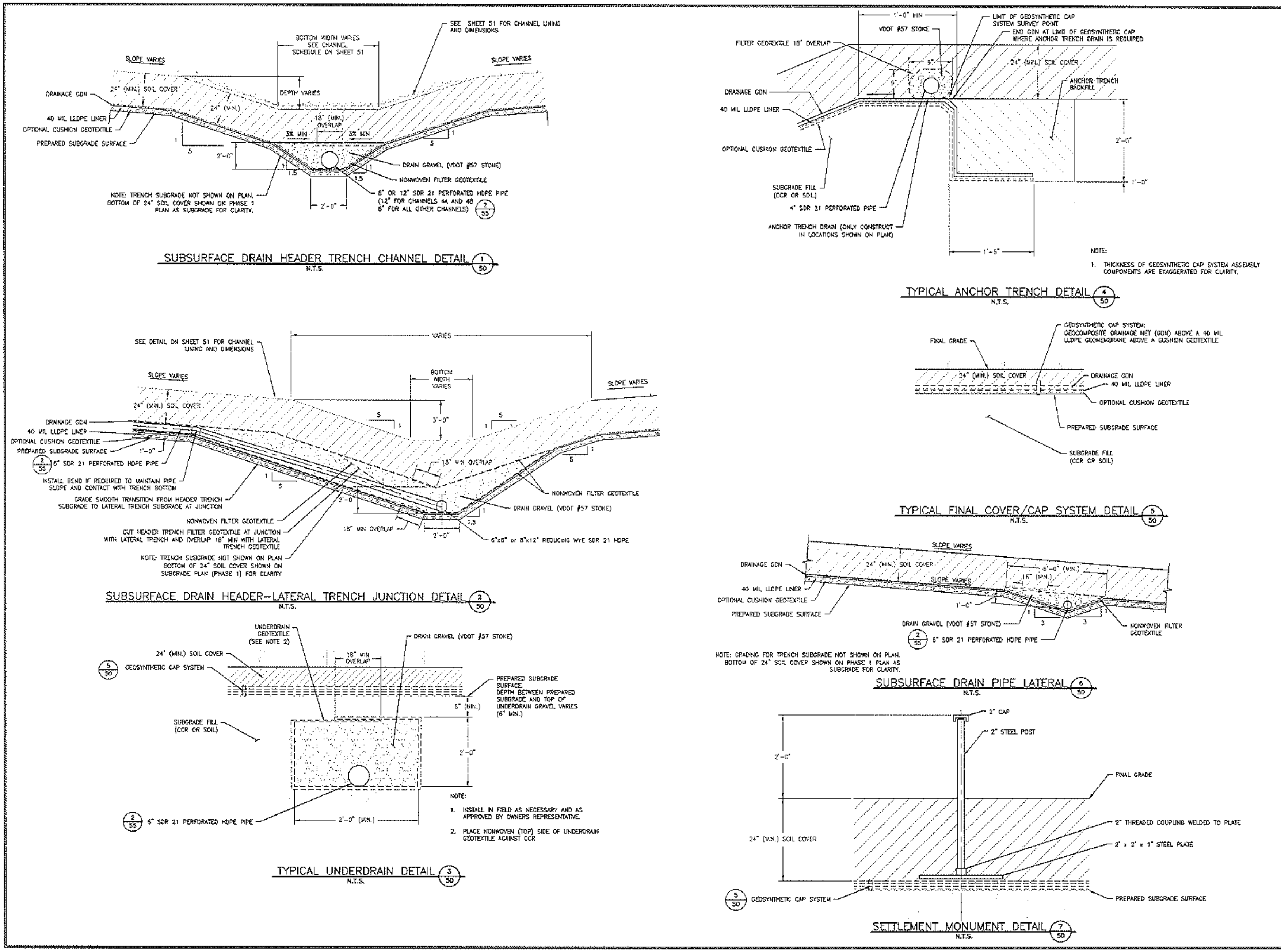

DRAWING TITLE
DETAILS - CAP SYSTEM (SHEET 1 OF 2)

PROJECT
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL SURFACE IMPOUNDMENT CLOSURES
DUMFRIES, VA

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GAI FILE NUMBER: C150132-00-000-C-D1-050
ALT./CLIENT DRAWING NUMBER:
GAI DRAWING NUMBER: 050

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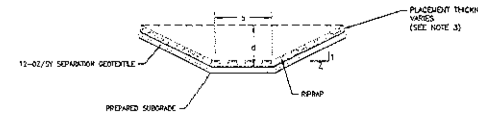

RIPRAP–LINED CHANNEL (1/51)
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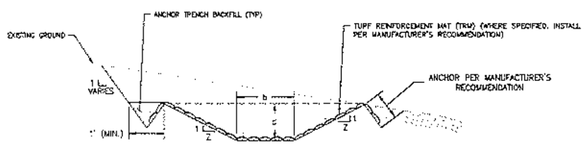
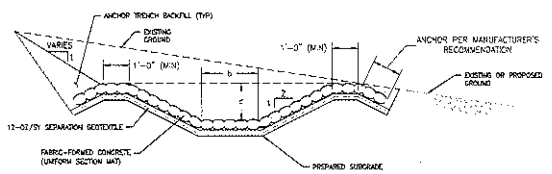


GRASS–LINED CHANNEL (2/51)
N.T.S.

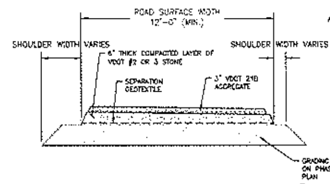


FABRIC–FORMED CONCRETE LINED CHANNEL (3/51)
N.T.S.

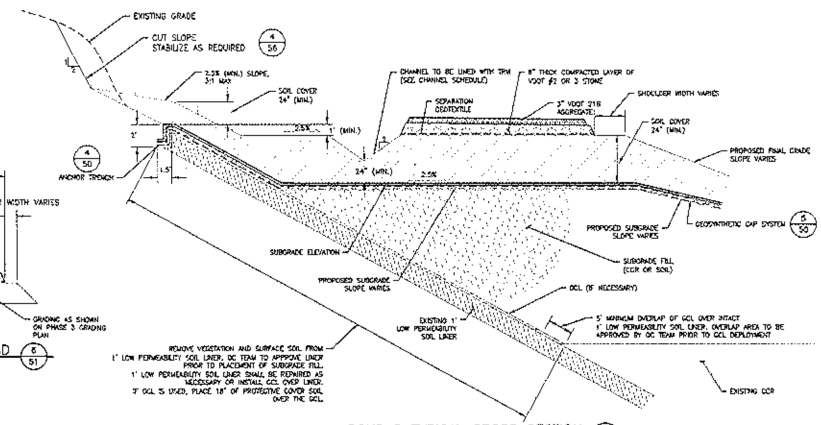
CHANNEL SCHEDULE				
CHANNEL ID	LINING	BOTTOM WIDTH, b (FT)	DEPTH, d (FT)	SIDE SLOPES, z
Channel B-1	P-550 TRM	4	1.5	3
Channel B-2	P-550 TRM	4	1.5	3
Channel B-3	SC-250 TRM	6	2.5	3
Channel C-1	SC-250 TRM	4	2	3
Channel C-2	SC-250 TRM	4	2	3
Channel C-3	SC-250 TRM	6	2	3
Channel D-1	SC-250 TRM	10	3	5
Channel D-2	SC-250 TRM	10	3	5
Channel D-3	SC-250 TRM	10	3	5
Channel D-4A	SD-475-OCT CCM	25	4	5
Channel D-4B	SC-250 TRM	25	3	5
Channel E-1	P-550 TRM	15	4	2
Channel E-2	P-550 TRM	10	2.5	2
Channel E-2A	4" Fabric Form Concrete	3	1.5	2
Channel E-3	SC-250 TRM	10	2	2
Channel E-4	P-550 TRM	10	1	2
Channel E-4A	P-550 TRM	10	0.5	2
Channel E-5	SC-250 TRM	10	1	2
Channel E-5A	SC-250 TRM	10	0.5	2
Channel E-6	SC-250 TRM	15	1.5	2
Channel E-6A	SC-250 TRM	10	0.5	2
Pond E Outlet Channel (See Note 5)	P-550 TRM	15	3.5	2
Basin E-1 Spillway	8" Fabric Form Concrete	20	2	6
Basin C-1 Spillway	Class AI Riprap	4	2	3
Basin B-1 Spillway	Class AI Riprap	4	2	3
Channel AR-1 Through AR-19	SC-250 TRM	6	2	5

CHANNEL SCHEDULE NOTES:

1. TRM = TURF REINFORCED MAT, CCM = CELLULAR CONCRETE MATTRESS.
2. ALL CHANNEL LINING PROTECTION AND DIMENSIONS SHALL BE CONSIDERED MINIMUM FINISHED DIMENSIONS WITH LINING.
3. PLACEMENT THICKNESS FOR CLASS II ROCK IS 45". PLACEMENT THICKNESS FOR CLASS AI ROCK IS 27".
4. CONTRACTOR TO PROVIDE NORTH AMERICAN GREEN TRM LINING AS SHOWN IN CHANNEL SCHEDULE OR EQUIVALENT PRODUCT AS APPROVED BY OWNER'S REPRESENTATIVE.
5. THE POND E OUTLET CHANNEL BEGINS DOWNSTREAM OF THE CONFLUENCE WITH CHANNEL E-1 AND E-3. THE DIMENSIONS SHOWN ON THE CHANNEL SCHEDULE ARE THE MINIMUM DIMENSIONS FOR THIS CHANNEL, WHICH TAPERS OUT TO PROVIDE 10:1 DRIVEABLE SIDE SLOPES NEAR THE DISCHARGE LOCATION. THE TRM LINING WILL TRANSITION TO AN 8 INCH THICK FABRICFORM CONCRETE LINING ON THE DRIVEABLE SURFACE, AND THEN TRANSITION BACK TO VEGETATION BEFORE DISCHARGING INTO THE TRIBUTARY OF QUANTICO CREEK. REFER TO PLAN VIEW SHEET 44.



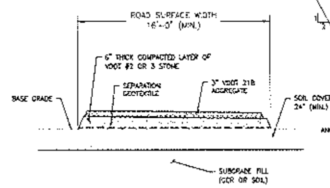
POND D INTERNAL ACCESS ROAD (6/51)
N.T.S.



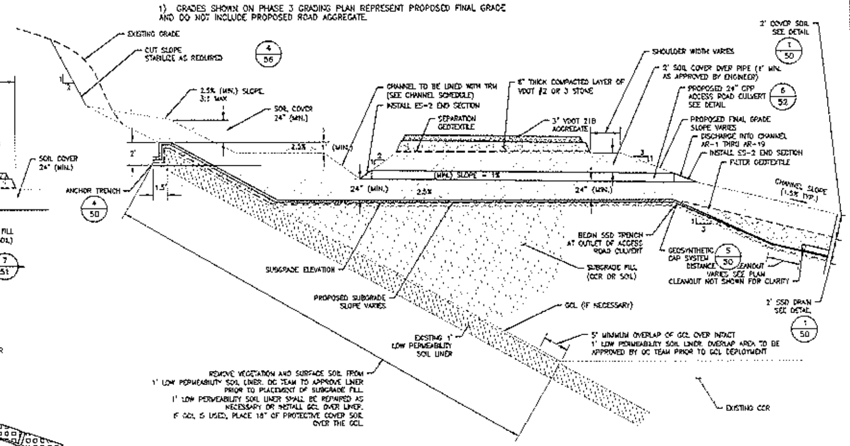
POND D TYPICAL CROSS SECTION (4/51)
N.T.S.

NOTE:

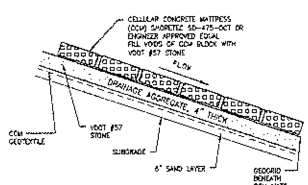
1) GRADES SHOWN ON PHASE 3 GRADING PLAN REPRESENT PROPOSED FINAL GRADE AND DO NOT INCLUDE PROPOSED ROAD AGGREGATE.



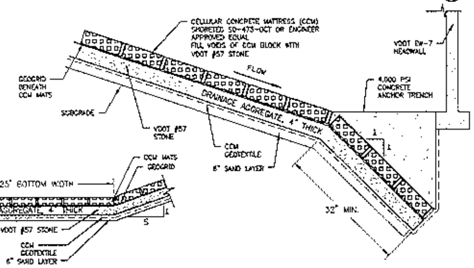
POND E ACCESS ROAD (7/51)
N.T.S.



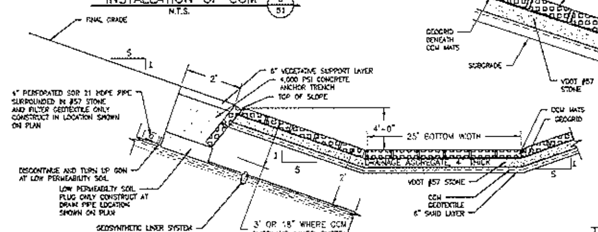
POND D TYPICAL CROSS SECTION WITH DRAINAGE PIPE (5/51)
N.T.S.



INSTALLATION OF CCM (8/51)
N.T.S.



TOE–IN CCM TERMINATION (10/51)
N.T.S.



LATERAL CCM TERMINATION ON EMBANKMENT – CCM PROTECTION (9/51)
N.T.S.

Culvert Schedule				
Name	Diameter (in)	Length (in)	Invert Elevation In	Invert Elevation Out
AR-1	24	40	136.0	111.2
AR-2	24	40	128.3	125.4
AR-3	24	65	123.5	120.4
AR-4	24	70	130.5	127.0
AR-5	24	75	137.3	134.0
AR-6	24	55	143.8	140.8
AR-7	24	40	148.5	145.3
AR-8	24	65	152.9	149.2
AR-9	24	65	156.5	152.4
AR-11	24	40	154.7	151.6
AR-12	24	40	140.0	136.5
AR-13	24	40	142.0	139.0
AR-14	24	40	138.8	135.2
AR-15	24	40	132.0	129.0
AR-16	24	40	125.1	121.8
AR-17	24	40	119.3	116.3
AR-18	24	40	110.4	107.5
AR-19	24	40	137.2	134.6
D-2	24	40	132.6	129.1
D-3	24	40	144.1	140.7

NO.	DATE	DRWN	CHKD	APVD	DESCRIPTION

REVISION RECORD

DRAWING TITLE
DETAILS - CAP SYSTEM (SHEET 2 OF 2)

PROJECT
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA

gai consultants

CLIENT
VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA

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SHEET NO.: 51 OF 65
REVISION:
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GAI DRAWING NUMBER: 051

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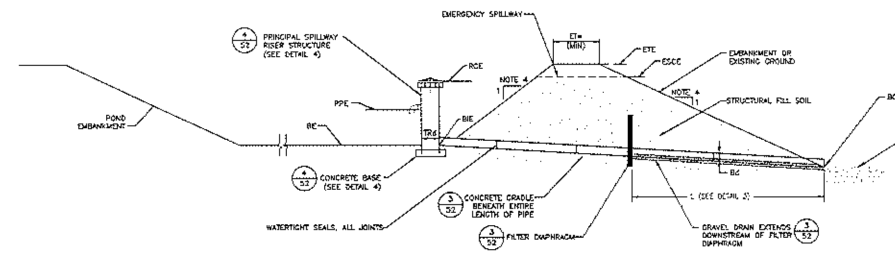
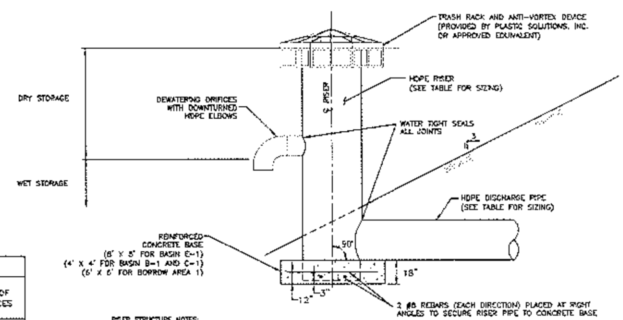


LOCATION	PRINCIPAL SPILLWAY RISER			PRINCIPAL SPILLWAY BARREL					EMBANKMENT				STORAGE DATA					DEWATERING	
	DIA TRd (IN)	RCE (FT)	MATERIAL OF CONSTRUCTION	DIA Bd (IN)	INLET ELEV. BIE (FT)	MATERIAL OF CONSTRUCTION	LENGTH (FT)	OUTLET ELEV. BOE (FT)	TOP ELEV. ETE (FT)	TOP WIDTH ETw (FT)	BOTTOM ELEV. BE (FT)	EMERGENCY SPILLWAY CREST ELEV. ESCE (FT)	CLEAN-OUT ELEV. COE (FT)	PERMANENT POOL ELEV. PPE (FT)	VOLUME AT RCE (AC-FT)	VOLUME AT ESCE (AC-FT)	VOLUME AT ETE (AC-FT)	ORIFICE DIA. (IN)	NO. OF ORIFICES
Basin E-1	48	9.7	SDR 32.5 HDPE	24	7.5	SDR 26 HDPE	105	7	13.5	15	4	11	5.8	7.5	21.5	28.3	46.6	8	3
Basin B-1	24	13	SDR 26 HDPE	12	11	SDR 17 HDPE	70	10	18	6	10	14	11	12	2.7	4.7	20	6	2
Basin C-1 (See Note 1)	24	13	SDR 26 HDPE	12	11	SDR 17 HDPE	70	10	18	6	10	14	11	12	2.0	3.4	14.2	6	2
BORROW AREA 1	36	92	SDR 32.5 HDPE	18	89	SDR 26 HDPE	70	84	95	6	90	N/A	90.5	91	2.2	N/A	6.1	6	2

TEMPORARY SEDIMENTATION POND – TYPICAL SECTION (1/52)
N.T.S.

NOTES:

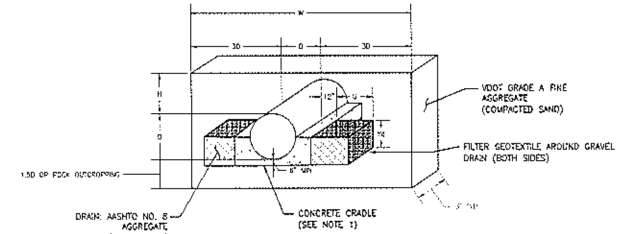
1. IF THE EXISTING POND C SPILLWAY STRUCTURE IS MODIFIED AS SHOWN IN DETAIL 2/52, THEN THE PRINCIPAL SPILLWAY INDICATED IN THIS TABLE IS NOT REQUIRED.
2. THIS DETAIL IS NOT SHOWN TO SCALE AND THE ARRANGEMENT VARIES FOR EACH BASIN. REFER TO THE TABULATED VALUES AND PLAN VIEW DRAWINGS FOR DESIGN ELEVATIONS AND LENGTHS.
3. ORIFICE OPENINGS ARE TO BE LOCATED ON THE OPPOSITE SIDE OF THE RISER FROM THE OUTLET BARREL. A MINIMUM OF 6 INCHES SHALL BE PROVIDED BETWEEN ORIFICE OPENINGS.
4. EMBANKMENT SIDE SLOPE TO BE EXISTING EMBANKMENT SLOPE OR 3H:1V FOR NEWLY CONSTRUCTED OR RECONSTRUCTED SLOPES.



RISER STRUCTURE NOTES:

1. CONTRACTOR SHALL PROVIDE SHOP DRAWING TO THE ENGINEER FOR APPROVAL PRIOR TO ORDERING THE RISER STRUCTURE.
2. CONTRACTOR SHALL PROVIDE SHOP DRAWING OF CONCRETE REINFORCEMENT TO THE ENGINEER FOR APPROVAL.

RISER STRUCTURE (4/52)
N.T.S.



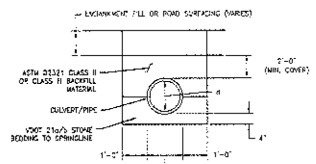
FILTER DIAPHRAGM NOTES:

1. THE CONCRETE CRADLE SHALL SUPPORT THE BARREL FOR ITS ENTIRE LENGTH, FROM THE RISER TO THE OUTLET. MINIMUM COMPRESSIVE STRENGTH FOR THE CONCRETE IS 4,000 PSI.
2. THE GRAVEL DRAIN SHALL BE PROVIDED DOWNSTREAM OF THE SAND FILTER DIAPHRAGM TO THE OUTLET.

FILTER DIAPHRAGM SCHEDULE

BASIN ID	DIAPHRAGM LOCATION, L (FT)	PIPE DIAMETER, D (FT)	DIAPHRAGM WIDTH, W (FT)	HEIGHT, H (FT)	DRAIN WIDTH, U (FT)	DRAIN HEIGHT, Yd (FT)
E-1	22	2	14	3.5	4	0.6
B-1	21	1	7	3	4.5	0.4
C-1	21	1	7	3	4.5	0.4
BORROW AREA 1	40.5	1.5	10.5	4.5	4.25	2.1

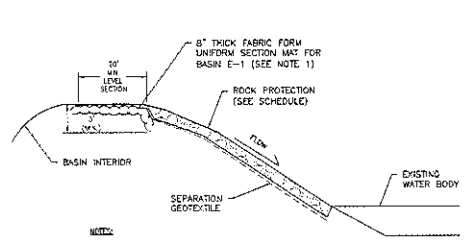
FILTER DIAPHRAGM, CONCRETE CRADLE AND GRAVEL DRAIN (3/52)
N.T.S.



NOTES:

1. 1' MINIMUM CLEARANCE BETWEEN MULTIPLE CULVERTS AND BETWEEN PIPE AND EDGE OF TRENCH.
2. EMBANKMENT AND ROAD SURFACING MATERIAL SHALL MEET PROJECT SPECIFICATIONS.
3. COMPACT 21a/b AND CLASS I/II BACKFILL IN 6" MAXIMUM LIFTS TO 95% OF THE MAXIMUM DRY DENSITY.

TYPICAL HDPE CULVERT AND PIPE TRENCH (6/52)
N.T.S.



NOTES:

1. FOR BASINS B-1 AND C-1 THE ROCK LINING WILL EXTEND TO THE UPSTREAM END OF THE LEVEL SECTION.

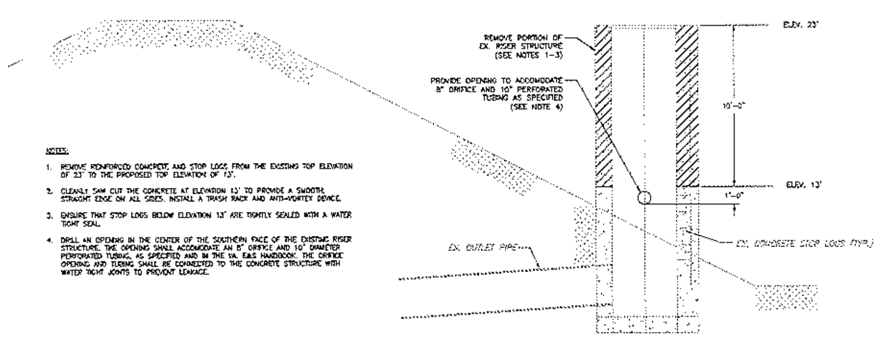
SLOPE PROTECTION SCHEDULE		
LOCATION	ROCK TYPE	PLACEMENT THICKNESS
BASIN E-1	CLASS I	36"
BASIN B-1	CLASS AI	27"
BASIN C-1	CLASS AI	27"

EMERGENCY SPILLWAY SLOPE PROTECTION (5/52)
N.T.S.

OUTLET PROTECTION						
LOCATION	DISCHARGE CONDITION	APRON LENGTH (FT)	UPSTREAM WIDTH (FT)	DOWNSTREAM WIDTH (FT)	ROCK CLASS	PLACEMENT THICKNESS (IN)
BASIN E-1 PRINCIPAL SPILLWAY	OPEN AREA	18	6	20	I	36
BASIN B-1 PRINCIPAL SPILLWAY	OPEN AREA	10	3	10	AI	27
BASIN C-1 PRINCIPAL SPILLWAY	OPEN AREA	10	3	10	AI	27
BORROW AREA 1 BASIN	SEE NOTE 2	N/A	N/A	N/A	I	36
CULVERT E-1	DEFINED CHANNEL	26	15	15	I	36
CULVERT B-1	DEFINED CHANNEL	10	7.5	7.5	AI	27
CULVERT B-2	DEFINED CHANNEL	8	7.5	7.5	AI	27

OUTLET PROTECTION NOTES:

1. SEE SHEET 55 FOR TYPICAL PIPE OUTLET CONDITIONS.
2. CULVERT DISCHARGES TO A LOCAL DEPRESSION. INSTALL ROCK ALL AROUND INTERIOR OF DEPRESSION TO ELEV. 86'



NOTES:

1. REMOVE REINFORCED CONCRETE AND STOP LOGS FROM THE EXISTING TOP ELEVATION OF 23' TO THE PROPOSED TOP ELEVATION OF 13'.
2. CLEANLY SAW CUT THE CONCRETE AT ELEVATION 13' TO PROVIDE A SMOOTH, STRAIGHT EDGE ON ALL SIDES. INSTALL A TRASH RACK AND ANTI-VORTEX DEVICE.
3. ENSURE THAT STOP LOGS BELOW ELEVATION 13' ARE TIGHTLY SEALED WITH A WATER TIGHT SEAL.
4. DRILL AN OPENING IN THE CENTER OF THE SOUTHERN FACE OF THE EXISTING RISER STRUCTURE. THE OPENING SHALL ACCOMODATE AN 8" ORIFICE AND 10" DIAMETER PERFORATED TUBING, AS SPECIFIED AND IN THE VA. E&S HANDBOOK. THE ORIFICE OPENING AND TUBING SHALL BE CONNECTED TO THE CONCRETE STRUCTURE WITH WATER TIGHT JOINTS TO PREVENT LEAKAGE.

MODIFICATION OF EXISTING POND A,B,C RISER STRUCTURE (2/52)
N.T.S.

CULVERT SCHEDULE

CULVERT ID	DIAMETER (IN.)	MATERIAL	NO. OF BARRELS	INLET INVERT EL.	INLET HEADWALL	OUTLET INVERT EL.	OUTLET HEADWALL	LENGTH (FT) (SEE NOTE 2)
E-1	42	CPP	3	49	DW-7	46	DW-7	55
B-1	30	CPP	1	24.5	ES-2	23.5	ES-2	50
B-2	30	CPP	1	24	ES-2	23.5	ES-2	50

CULVERT SCHEDULE NOTES:

1. ALL PIPES IDENTIFIED SHALL USE THE SPECIFIED MATERIAL AND TYPE UNLESS APPROVED BY THE OWNER'S REPRESENTATIVE.
2. CULVERT LENGTH LISTED IS HORIZONTAL DIMENSION.

NO.	DATE	DESCRIPTION	DWN.	CHK.	APV.

REVISION RECORD

DRAWING TITLE
DETAILS - STORMWATER (1 OF 2)

CLIENT
VIRGINIA ELECTRIC AND POWER COMPANY
GLEN ALLEN, VA

gai consultants

PROJECT
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL SURFACE IMPOUNDMENT CLOSURES
DUMFRIES, VA

ISSUING OFFICE: Richmond | 4198 Cox Road, Suite 114, Glen Allen, VA 23060

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11/18/2015

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	N.T.S.	11/18/2015

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GAI FILE NUMBER: C150132-00-000-C-D1-052
ALT./CLIENT DRAWING NUMBER:
GAI DRAWING NUMBER: 052

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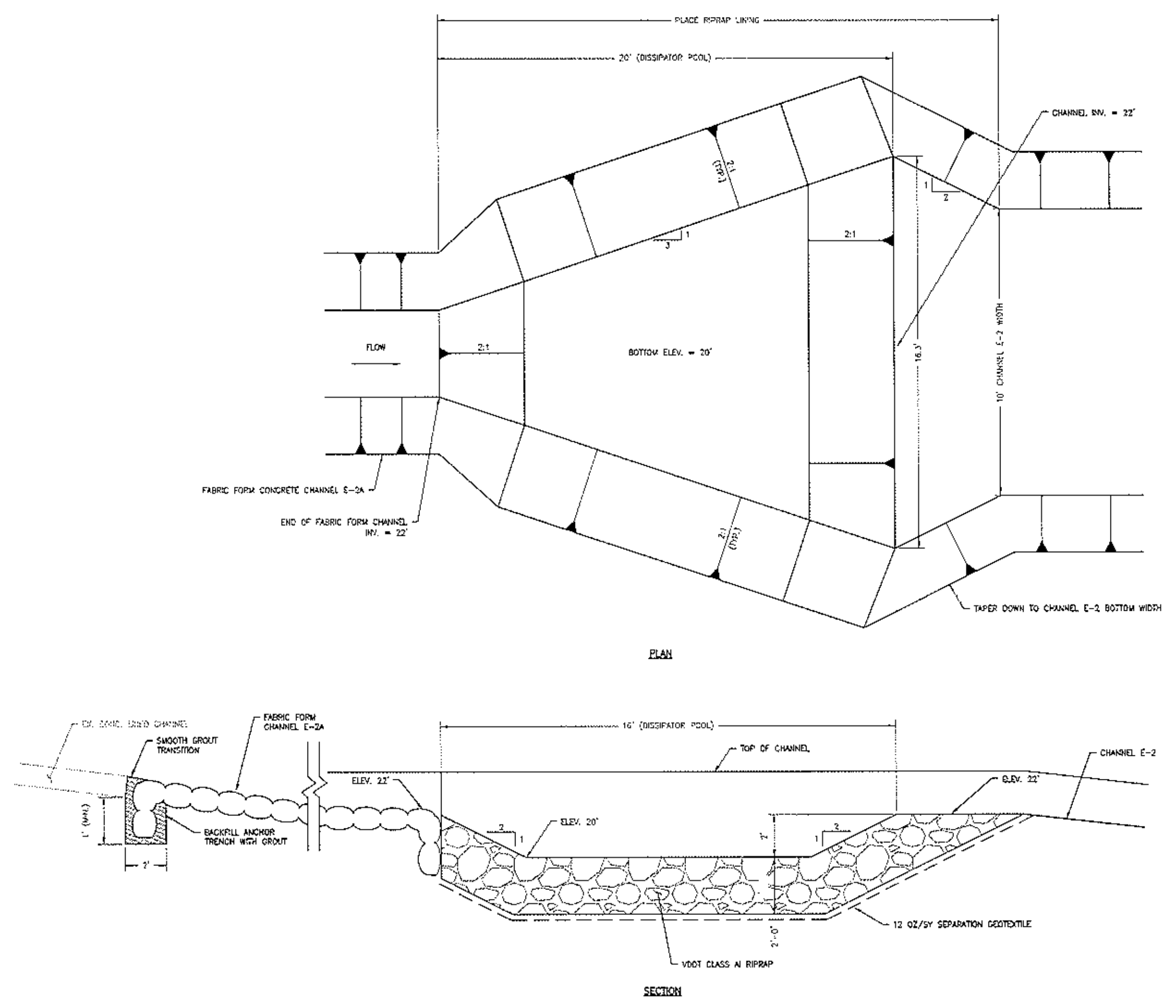

ENERGY DISSIPATOR 1/53
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DRAWING TITLE: DETAILS - STORMWATER (2 OF 2)

PROJECT: POSSUM POINT POWER STATION COAL COMBUSTION RESIDUAL SURFACE IMPOUNDMENT CLOSURES DUMFRIES, VA

CLIENT: VIRGINIA ELECTRIC AND POWER COMPANY GLEN ALLEN, VA

gai consultants

ISSUING OFFICE: Richmond | 4198 Cox Road, Suite 114, Glen Allen, VA 23060

NO.	DATE	DWN.	CHK.	APV.	DESCRIPTION

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11/18/2015

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DOYLEMP	KINDEXW	KLAMUJR
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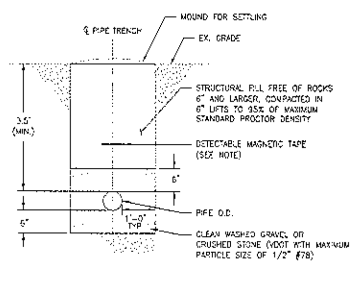
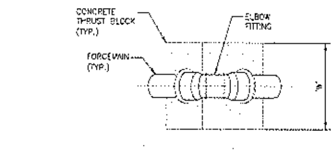


NON-PAVED AREA

NOTES:
1. DETECTABLE TAPE SHALL BE PLACED ONE FOOT ABOVE THE PIPE AND SHALL HAVE A METALLIC CORE PROTECTED BY A PLASTIC JACKET. THE TAPE SHALL BE CONTINUOUSLY MARKED INDICATING THAT A FORCEMAIN IS BURIED. THE TAPE SHALL BE MAGNETIC AND SHALL BE SAFETY GREEN IN COLOR.

STANDARD DETAIL
SEWER PIPE INSTALLATION TRENCH (1/54)
N.T.S.



PLAN
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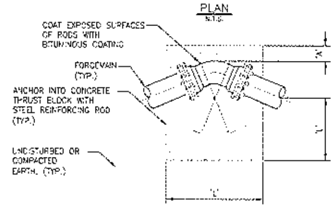
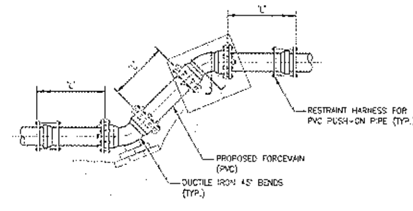


ELEVATION
N.T.S.

NOTES:
1. DUCTILE IRON FITTINGS TO BE POLYETHYLENE WRAPPED PRIOR TO BEDDING AND CONCRETE BLOCK PLACEMENT.
2. CONCRETE STRENGTH 3000 PSI AT 28 DAYS.

DIMENSION SCHEDULE													
PIPE SIZE	PIPE TYPE	11.25° ELBOW				22.5° ELBOW				45° ELBOW			
		'A'	'W'	'L'	ROD Ø	'A'	'W'	'L'	ROD Ø	'A'	'W'	'L'	ROD Ø
4"	PVC	6"	18"	18"	#7	6"	24"	24"	#7	8"	30"	30"	#7

STANDARD DETAIL
CAST-IN-PLACE THRUST BLOCKS
FOR UPPER VERTICAL ELBOW FITTINGS (3/54)
N.T.S.



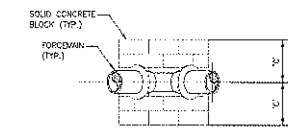
ELEVATION
N.T.S.

RESTRAINED JOINT SCHEDULE - UPPER VERTICAL ELBOW				
PIPE SIZE	PIPE TYPE	11.25° ELBOW	22.5° ELBOW	45° ELBOW
		'L'	'L'	'L'
4"	PVC	4	8	15

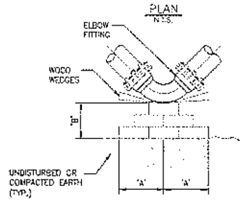
RESTRAINED JOINT SCHEDULE - LOWER VERTICAL ELBOW				
PIPE SIZE	PIPE TYPE	11.25° ELBOW	22.5° ELBOW	45° ELBOW
		'L'	'L'	'L'
4"	PVC	2	3	5

NOTES:
1. DIMENSION 'L' REPRESENTS THE LENGTH OF RESTRAINED PIPE REQUIRED IN FEET ON EACH SIDE OF THE PIPE FITTING.
2. THE RESTRAINT REQUIREMENTS ARE BASED ON A SOIL OF CLAY WITH HIGH PLASTICITY, TRENCH TYPE 4 WITH COMPACTED GRANULAR BEDDING AND BACKFILL TO THE TOP OF THE PIPE, A COVER DEPTH OF 3.5 FEET AT UPPER ELBOW AND 5 FEET AT LOWER ELBOW, AND MAXIMUM OPERATING PRESSURE OF 150 PSI.
3. MECHANICAL JOINTS WITH RETAINER GLANDS SHOWN AT FITTINGS. GASKETED, PUSH-ON JOINT PVC FITTINGS WITH RESTRAINT HARNESSES ARE ALSO ACCEPTABLE.

STANDARD DETAIL
RESTRAINED JOINT SCHEDULE FOR VERTICAL FITTINGS (5/54)
N.T.S.



PLAN
N.T.S.

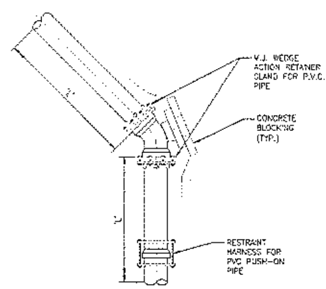


ELEVATION
N.T.S.

NOTES:
1. DUCTILE IRON FITTINGS TO BE POLYETHYLENE WRAPPED PRIOR TO BEDDING AND CONCRETE BLOCK PLACEMENT.

DIMENSION SCHEDULE												
PIPE SIZE	11.25° ELBOW			22.5° ELBOW			45° ELBOW			90° ELBOW		
	'A'	'B'	'C'	'A'	'B'	'C'	'A'	'B'	'C'	'A'	'B'	'C'
4"	6"	6"	6"	8"	8"	6"	11"	11"	8"	12"	12"	12"

STANDARD DETAIL
PRECAST THRUST BLOCKS
FOR LOWER VERTICAL ELBOW FITTINGS (2/54)
N.T.S.



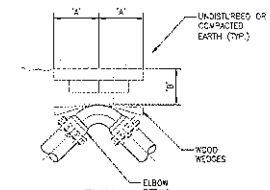
BEND OR FITTING – PVC
THROUGH 10-INCH

RESTRAINED JOINT SCHEDULE					
PIPE SIZE	PIPE TYPE	11.25° ELBOW	22.5° ELBOW	45° ELBOW	TEE BRANCH, 90° BEND, VALVE OR DEAD END
		'L'	'L'	'L'	'L'
4"	PVC	2	4	7	30

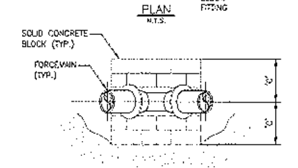
NOTES:
1. DIMENSION 'L' REPRESENTS THE LENGTH OF RESTRAINED PIPE REQUIRED IN FEET ON EACH SIDE OF THE PIPE FITTING.
2. THE RESTRAINT REQUIREMENTS ARE BASED ON A SOIL OF CLAY WITH HIGH PLASTICITY, TRENCH TYPE 4 WITH COMPACTED GRANULAR BEDDING AND BACKFILL TO THE TOP OF THE PIPE, A COVER DEPTH OF 3.5 FEET, AND MAXIMUM OPERATING PRESSURE OF 150 PSI.
3. MECHANICAL JOINTS WITH RETAINER GLANDS SHOWN AT FITTING. GASKETED, PUSH-ON JOINT PVC FITTINGS WITH RESTRAINT HARNESSES ARE ALSO ACCEPTABLE.

PLAN
N.T.S.

STANDARD DETAIL
RESTRAINED JOINT SCHEDULE FOR HORIZONTAL FITTINGS (4/54)
N.T.S.



PLAN
N.T.S.



ELEVATION
N.T.S.

NOTES:
1. DUCTILE IRON FITTINGS TO BE POLYETHYLENE WRAPPED PRIOR TO BEDDING AND CONCRETE BLOCK PLACEMENT.

DIMENSION SCHEDULE												
PIPE SIZE	11.25° ELBOW			22.5° ELBOW			45° ELBOW			90° ELBOW		
	'A'	'B'	'C'	'A'	'B'	'C'	'A'	'B'	'C'	'A'	'B'	'C'
4"	6"	6"	4"	6"	8"	6"	11"	11"	6"	12"	12"	12"

STANDARD DETAIL
PRECAST THRUST BLOCKS FOR HORIZONTAL ELBOW FITTINGS (6/54)
N.T.S.

NO.	DATE	DWN.	CHK.	APV.	DESCRIPTION

REVISION RECORD

DRAWING TITLE
DETAILS - MISCELLANEOUS (SHEET 1 OF 3)

PROJECT
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA

gai consultants

CLIENT
VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA

ISSUING OFFICE: Richmond | 4198 Cox Road, Suite 114, Glen Allen, VA 23060

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DOYLEMP	KINDEKW	KLAMUJR
DWG TYPE:	SCALE:	ISSUE DATE:
	AS SHOWN	11/18/2015

SHEET NO.: 54 OF 65
REVISION

GAI FILE NUMBER: C150132-00-000-C-D1-054

ALT./CLIENT DRAWING NUMBER:

GAI DRAWING NUMBER: 054

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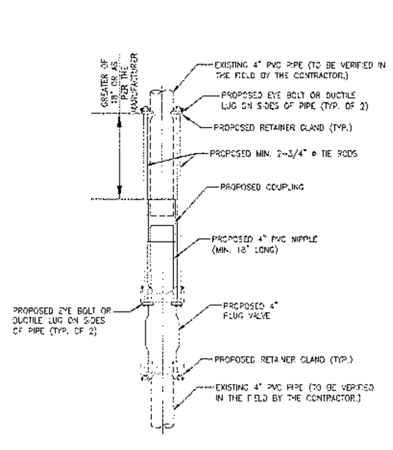
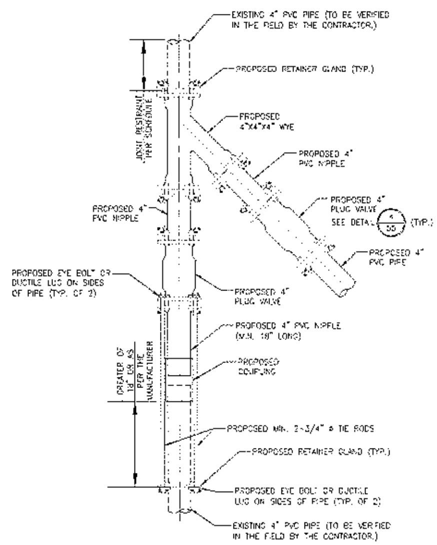
789



VALVE CUT-IN DETAIL

CUT-IN TO EXISTING FORCEMAIN (3/55)

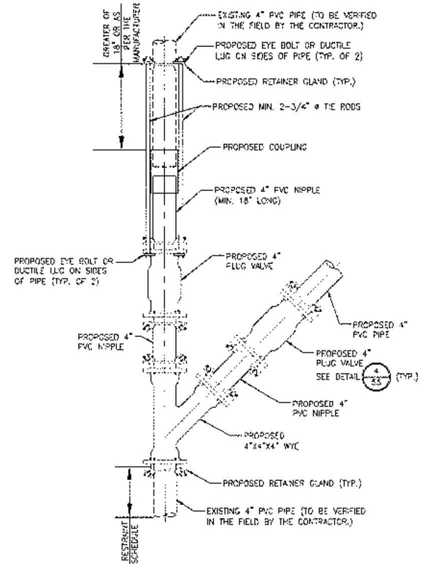
N.T.S.



CUT-IN DETAIL 1

CUT-IN TO EXISTING FORCEMAIN (2/55)

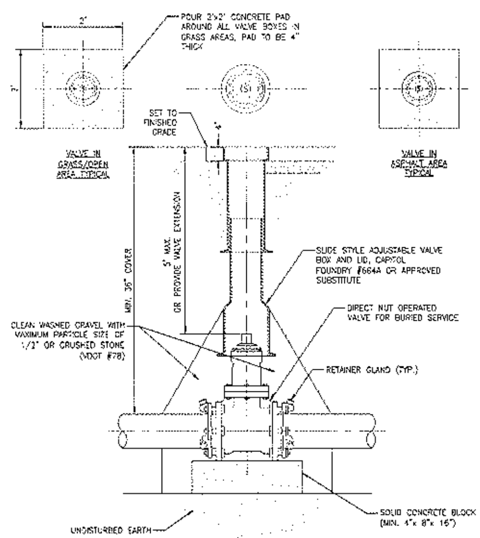
N.T.S.



CUT-IN DETAIL 2

CUT-IN TO EXISTING FORCEMAIN (3/55)

N.T.S.

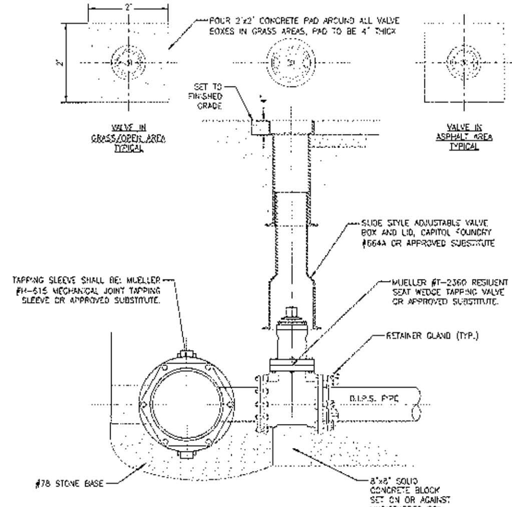


NOTES:
1. VALVES THAT ARE NORMALLY CLOSED, PROVIDE ACCESS INSERT AND PAINT TOP OF VALVE BOX RED.
2. VALVE AND PIPE SHALL HAVE SAME NOMINAL DIAMETER.
3. CONTRACTOR TO PROVIDE "T" WRENCH TO TURN OPERATOR.
4. VALVE SHALL NOT SUPPORT VALVE BOX.

STANDARD DETAIL

VALVE, VALVE BOX, AND COVER (4/55)

N.T.S.



NOTES:
1. TAPPING SLEEVE AND VALVE SHALL BE TESTED FOR 10 MIN. AT 200 PSI FOR SIZES 4" THRU 12" PRIOR TO TAPPING MAIN. TAPS LARGER THAN 12" WILL BE TESTED FOR 10 MIN AT 150 PSI
2. VALVE EXTENSION REQUIRED WHEN VALVE DEPTH FROM TOP OF OPERATING NUT TO FINISHED GRADE IS 5' OR GREATER

STANDARD DETAIL

TAPPING SLEEVE & VALVE DETAIL (5/55)

N.T.S.

CUT-IN DETAILS GENERAL NOTES:
1. RESTRAINED COUPLING WITH RETAINER GLANDS IS ALSO ACCEPTABLE.
2. DUCTILE IRON FITTINGS WITH RESTRAINED MECHANICAL JOINTS ARE SHOWN. GASKETED, PUSH-ON JOINT PVC FITTINGS WITH RESTRAINT HARNESSES ARE ALSO ACCEPTABLE.
3. PLUG VALVES SHALL BE RATED FOR BURIED SERVICE AND INCLUDE RESTRAINED MECHANICAL JOINTS.
4. JOINTS ARE TO BE RESTRAINED PER SCHEDULE PRIOR TO CLOSING VALVE.

NO.	DATE	DWN	CHK	APV	DESCRIPTION

REVISION RECORD

DRAWING TITLE
DETAILS - MISCELLANEOUS (SHEET 2 OF 3)

PROJECT
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA

gai consultants

CLIENT
VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA

ISSUING OFFICE: Richmond | 4198 Cox Road, Suite 114, Glen Allen, VA 23060

COMMONWEALTH OF VIRGINIA
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PROFESSIONAL ENGINEER

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DWG TYPE:	SCALE:	ISSUE DATE:
	AS SHOWN	11/18/2015

SHEET NO.: 55 OF 65

REVISION: △

GAI FILE NUMBER: C150132-00-000-C-D1-055

ALT./CLIENT DRAWING NUMBER:

GAI DRAWING NUMBER: 055

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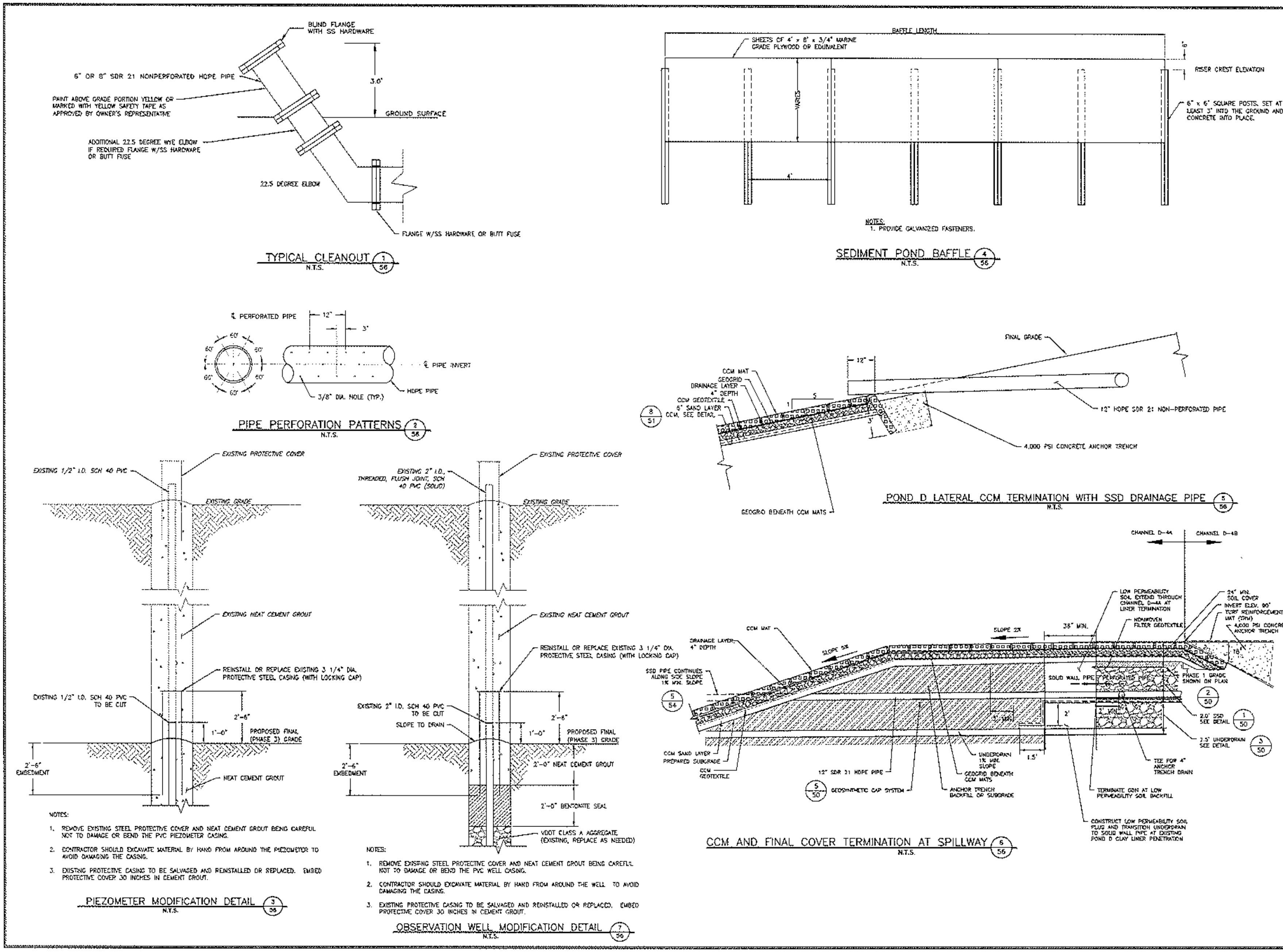

NO.	DATE	DWN.	CHK.	APV.	DESCRIPTION

REVISION RECORD

DRAWING TITLE
DETAILS - MISCELLANEOUS (SHEET 3 OF 3)

PROJECT
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA

gai consultants

CLIENT
VIRGINIA ELECTRIC AND
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ERIN R. KLAMUT
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DWG TYPE:	SCALE:	ISSUE DATE:
	AS SHOWN	11/18/2015

SHEET NO.: 56 OF 65
REVISION: △

GAI FILE NUMBER: C150132-00-000-C-D1-056

ALT./CLIENT DRAWING NUMBER:

GAI DRAWING NUMBER: 056

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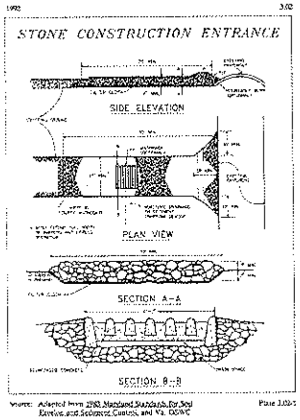
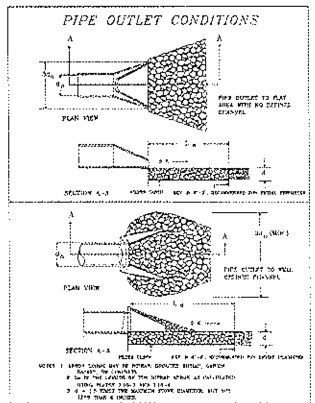
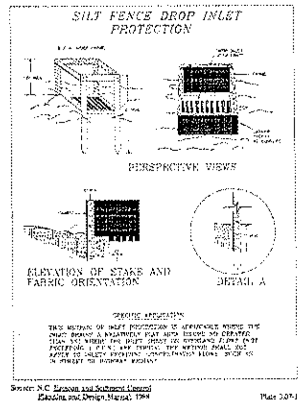


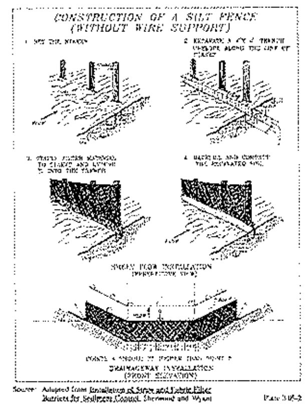
STONE CONSTRUCTION ENTRANCE (1/57) (CE)
N.T.S.



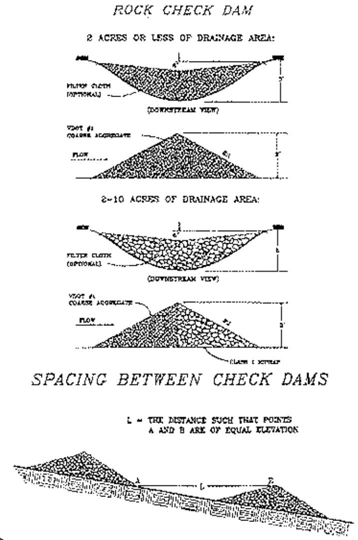
PIPE OUTLET PROTECTION (3/57) (OP)
N.T.S.



SILT FENCE DROP INLET PROTECTION (5/57) (IP)
N.T.S.



CONSTRUCTION OF A SILT FENCE WITHOUT WIRE SUPPORT (7/57) (SF)
N.T.S.

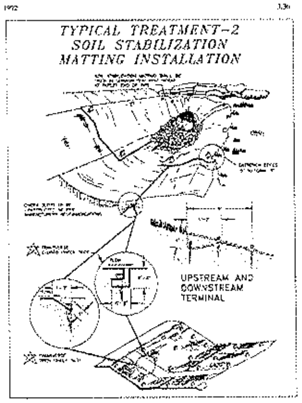


Maintenance

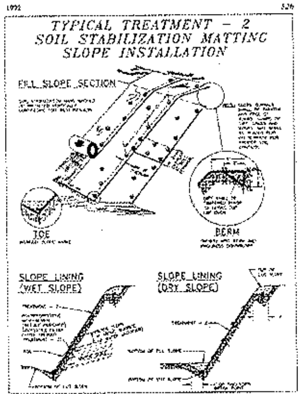
Check dams should be checked for sediment accumulation after each runoff-producing storm event. Sediment should be removed when it reaches one half of the original height of the measure.

Regular inspections should be made to insure that the center of the dam is lower than the edges. Erosion caused by high flows around the edges of the dam should be corrected immediately.

SPACING BETWEEN CHECK DAMS (9/57) (CD)
N.T.S.



TYPICAL TREATMENT – 2 SOIL STABILIZATION MATTING INSTALLATION (2/57)
N.T.S.

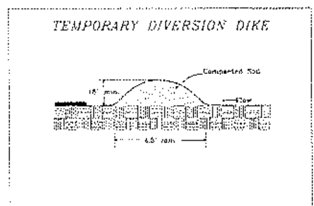


TYPICAL TREATMENT – 2 SOIL STABILIZATION SLOPE INSTALLATION (4/57)
N.T.S.

1992 3.09

Height

The minimum allowable height measured from the upslope side of the dike is 18 inches (see Plate 3.09-1).



Source: Va. DSWC Plate 3.09-1

Side Slopes

2:1 or flatter, along with a minimum base width of 4.5 feet (see Plate 3.09-1).

Grade

The channel behind the dike shall have a positive grade to a stabilized outlet. If the channel slope is less than or equal to 2%, no stabilization is required. If the slope is greater than 2%, the channel shall be stabilized in accordance with Std. & Spec. 3.17, STORMWATER CONVEYANCE CHANNEL.

Outlet

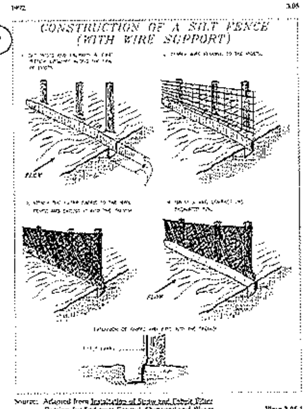
1. The diverted runoff, if free of sediment, must be released through a stabilized outlet or channel.

III - 54

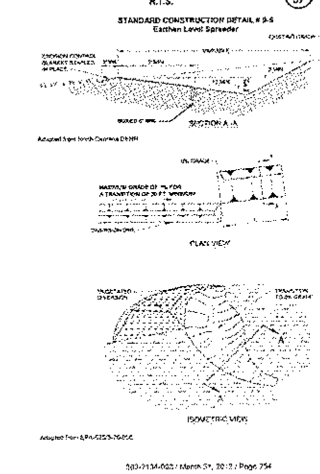
Maintenance

Before final stabilization, the diversion should be inspected after every rainfall and at least once every two weeks. Sediment shall be removed from the channel and repairs made as necessary. Seeded areas which fail to establish a vegetative cover shall be reseeded as necessary.

TEMPORARY DIVERSION DIKE (6/57) (DD)
N.T.S.



CONSTRUCTION OF A SILT FENCE WITH WIRE SUPPORT (8/57) (SSF)
N.T.S.



LEVEL SPREADER (10/57)
N.T.S.

DRAWING TITLE: DETAILS - EROSION AND SEDIMENT CONTROL (SHEET 1 OF 2)

PROJECT: POSSUM POINT POWER STATION COAL COMBUSTION RESIDUAL SURFACE IMPOUNDMENT CLOSURES DUMFRIES, VA

gai consultants

CLIENT: VIRGINIA ELECTRIC AND POWER COMPANY GLEN ALLEN, VA

NO.	DATE	DWN	CHK	APV	DESCRIPTION

REVISION RECORD

ISSUING OFFICE: Richmond | 4198 Cox Road, Suite 114, Glen Allen, VA 23060

JOHN R. KLAMUT Lic. No. 044459 11/18/2015

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BRIARS	KINDSKW	KLAMUJR
DWG TYPE	SCALE	ISSUE DATE
	AS SHOWN	11/18/2015

SHEET NO.: 57 OF 65

REVISION: △

GAI FILE NUMBER: C150132-00-000-C-D1-057

ALT./CLIENT DRAWING NUMBER

GAI DRAWING NUMBER: 057

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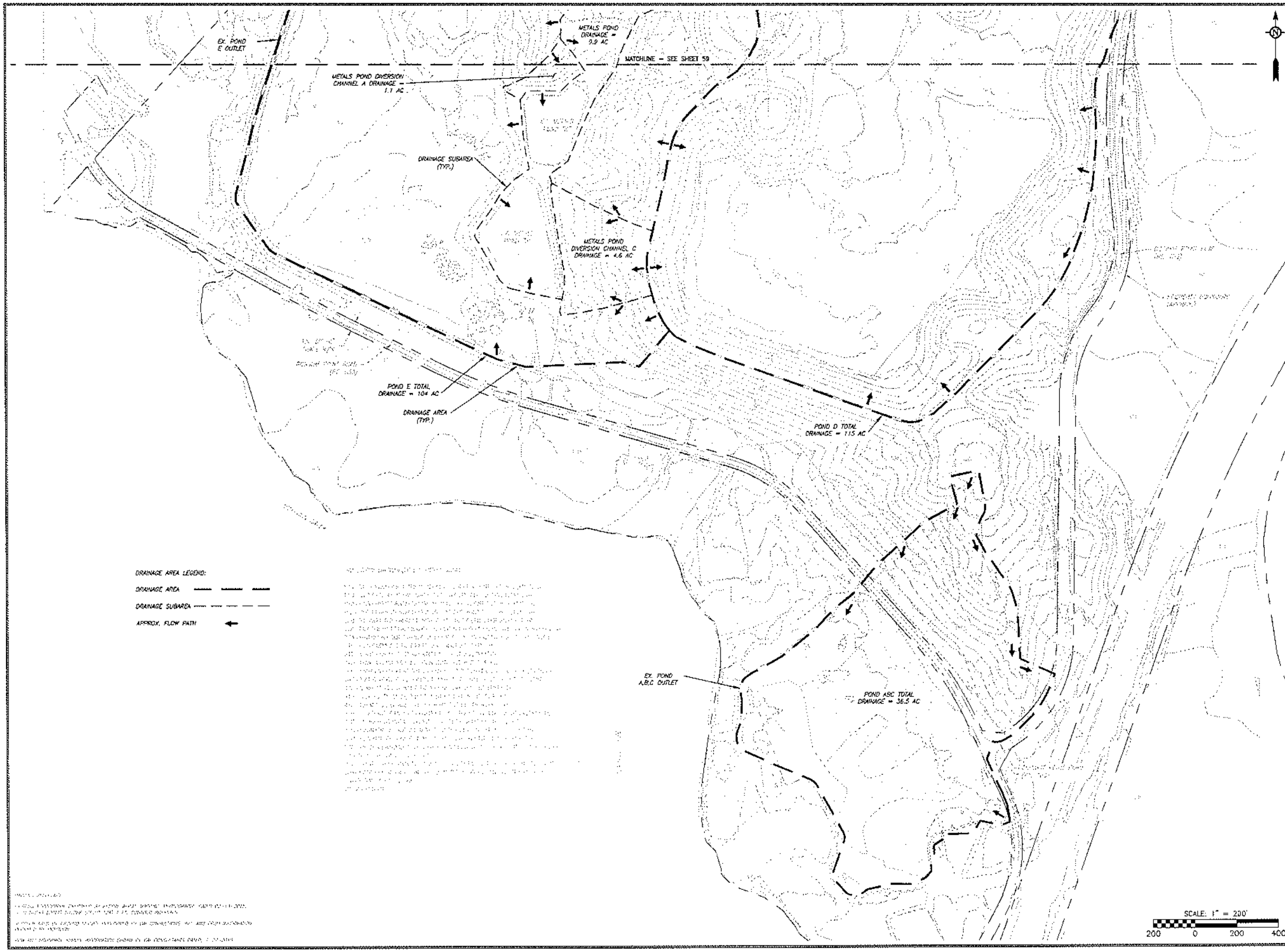

DRAWING TITLE
DRAINAGE AREA MAP - PREDEVELOPMENT (1 OF 2)

PROJECT
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA

gaiconsultants

CLIENT
VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA

ISSUING OFFICE: Richmond | 4198 Cox Road, Suite 114, Glen Allen, VA 23060

NO.	DATE	DWN.	CKK.	APV.	DESCRIPTION

REVISION RECORD

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DOYLEMP	XINDEKW	KLAMUJR
DWG TYPE:	SCALE:	ISSUE DATE:
	AS SHOWN	11/18/2015

SHEET NO.: 58 OF 65
REVISION
GAI FILE NUMBER: C150132-00-000-C-D1-058
ALT/CLIENT DRAWING NUMBER:
GAI DRAWING NUMBER: 058

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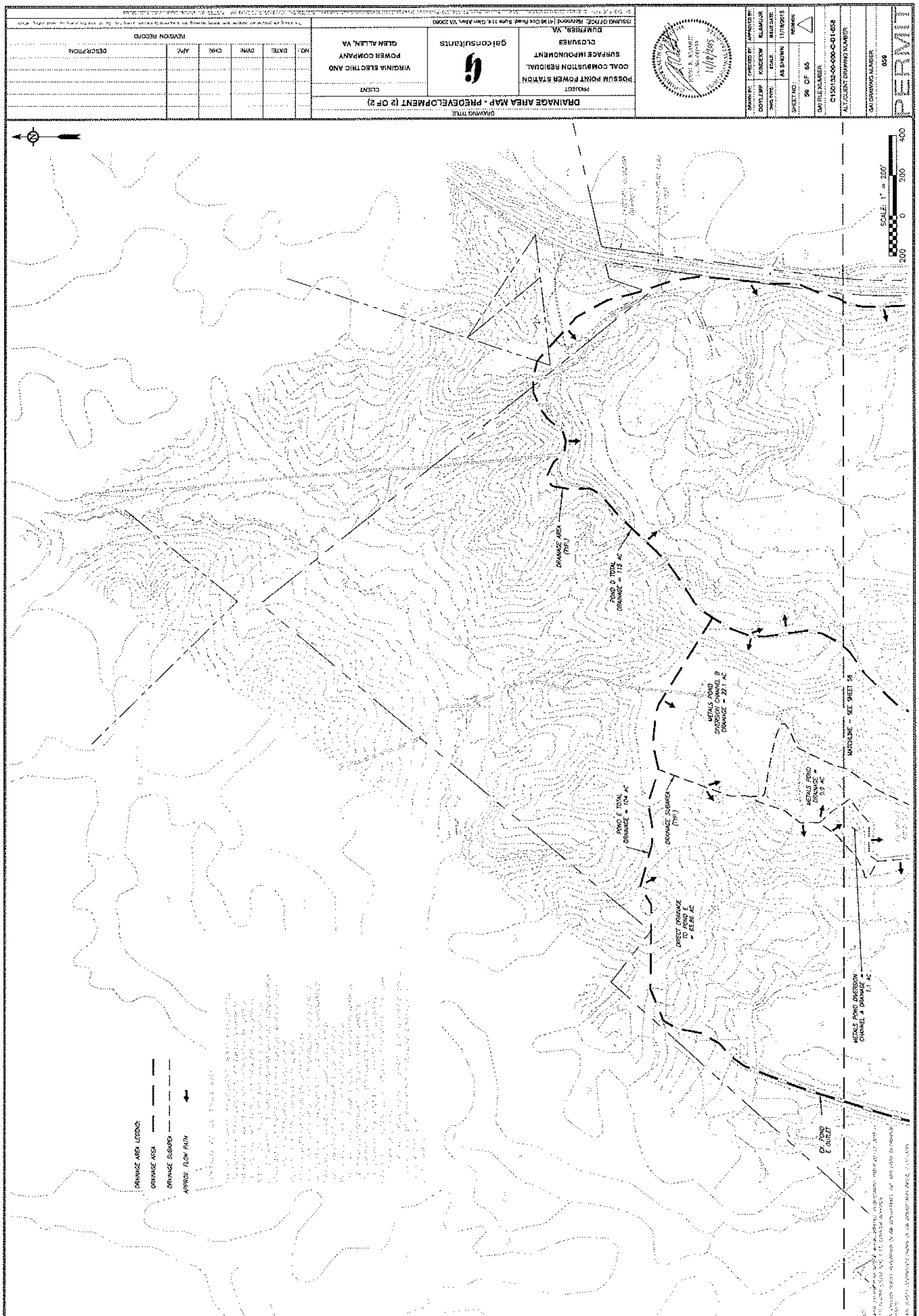
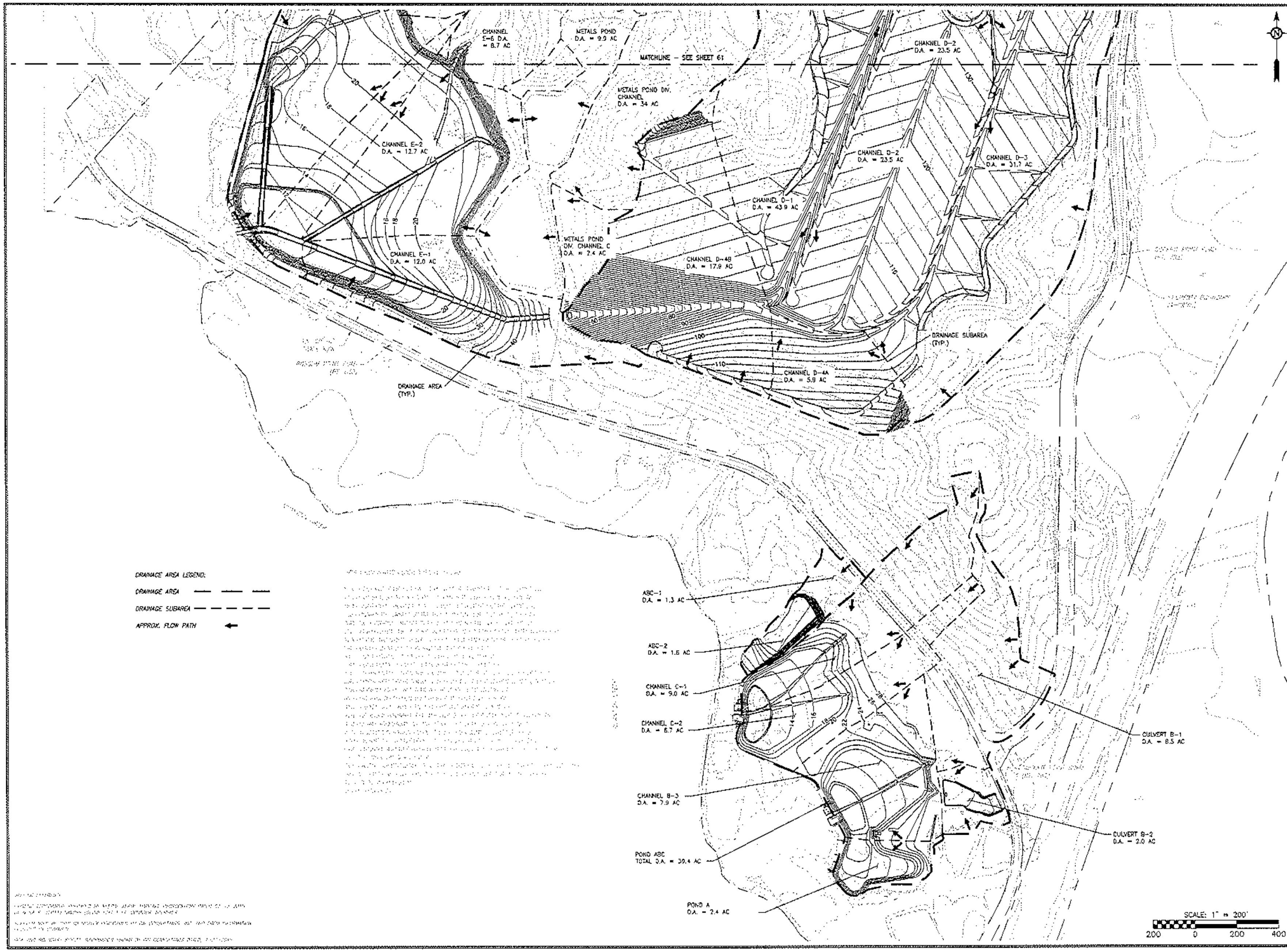

DRAINAGE AREA MAP - PREDEVELOPMENT (2 OF 2)
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA
VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA
gaiconsultants
59 OF 65
AS SHOWN
PERMIT
SCALE: 1" = 200'
DRAINAGE AREA (TYP.)
POND D TOTAL DRAINAGE = 115 AC
METALS POND DIVERSION CHANNEL B DRAINAGE = 22.1 AC
MATCHLINE - SEE SHEET 58
POND E TOTAL DRAINAGE = 104 AC
DRAINAGE SUBAREA (TYP.)
METALS POND DRAINAGE = 9.9 AC
DIRECT DRAINAGE TO POND E = 65.86 AC
METALS POND DIVERSION CHANNEL A DRAINAGE = 1.1 AC
EX. POND E OUTLET
DRAINAGE AREA LEGEND:
DRAINAGE AREA
DRAINAGE SUBAREA
APPROX. FLOW PATH



NO. | DATE | DWN | CHK | APV | DESCRIPTION
REVISION RECORD

DRAWING TITLE
DRAINAGE AREA MAP POST-DEVELOPMENT (1 OF 2)

PROJECT
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA

gai consultants

CLIENT
VIRGINIA ELECTRIC AND
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GLEN ALLEN, VA

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COMMONWEALTH OF VIRGINIA
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DWG TYPE:	SCALE:	ISSUE DATE:
	AS SHOWN	11/18/2015

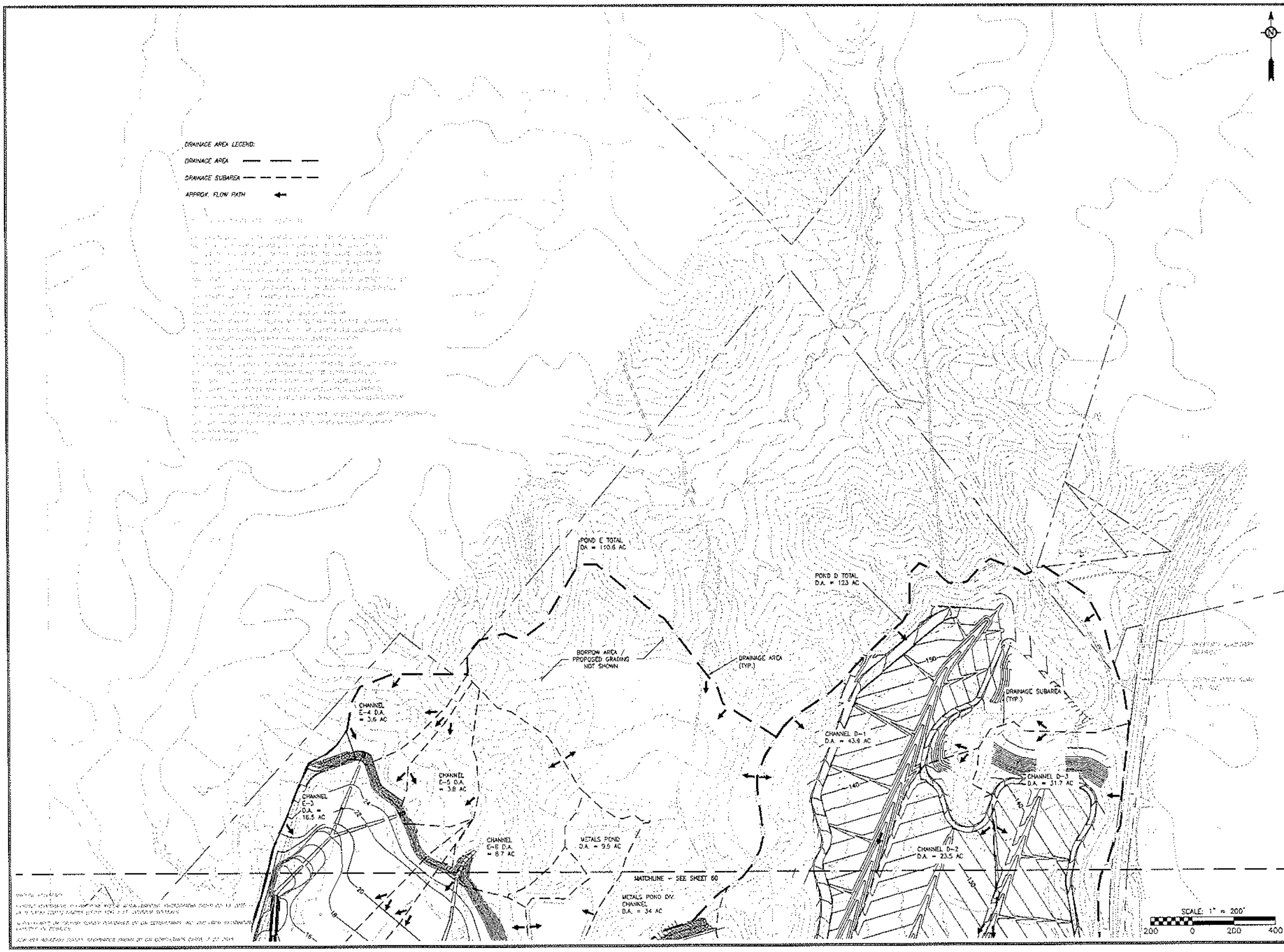
SHEET NO.: 60 OF 65
REVISION: △

GAI FILE NUMBER: C150132-00-000-C-D1-060

ALT./CLIENT DRAWING NUMBER:

GAI DRAWING NUMBER: 060

PERMIT



DRAWING TITLE

DRAINAGE AREA MAP POST-DEVELOPMENT (2 OF 2)

PROJECT

POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA

gai consultants

CLIENT

VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA

ISSUING OFFICE: Richmond | 4198 Cox Road, Suite 114, Glen Allen, VA 23060

NO.	DATE	DWN	CHK	APPD	DESCRIPTION

REVISION RECORD

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Lic. No. 048549
11/18/2015

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DOYLEMP	KINDEKW	KLAMUJR
DWG TYPE:	SCALE:	ISSUE DATE:
	AS SHOWN	11/18/2015

SHEET NO.: 61 OF 65

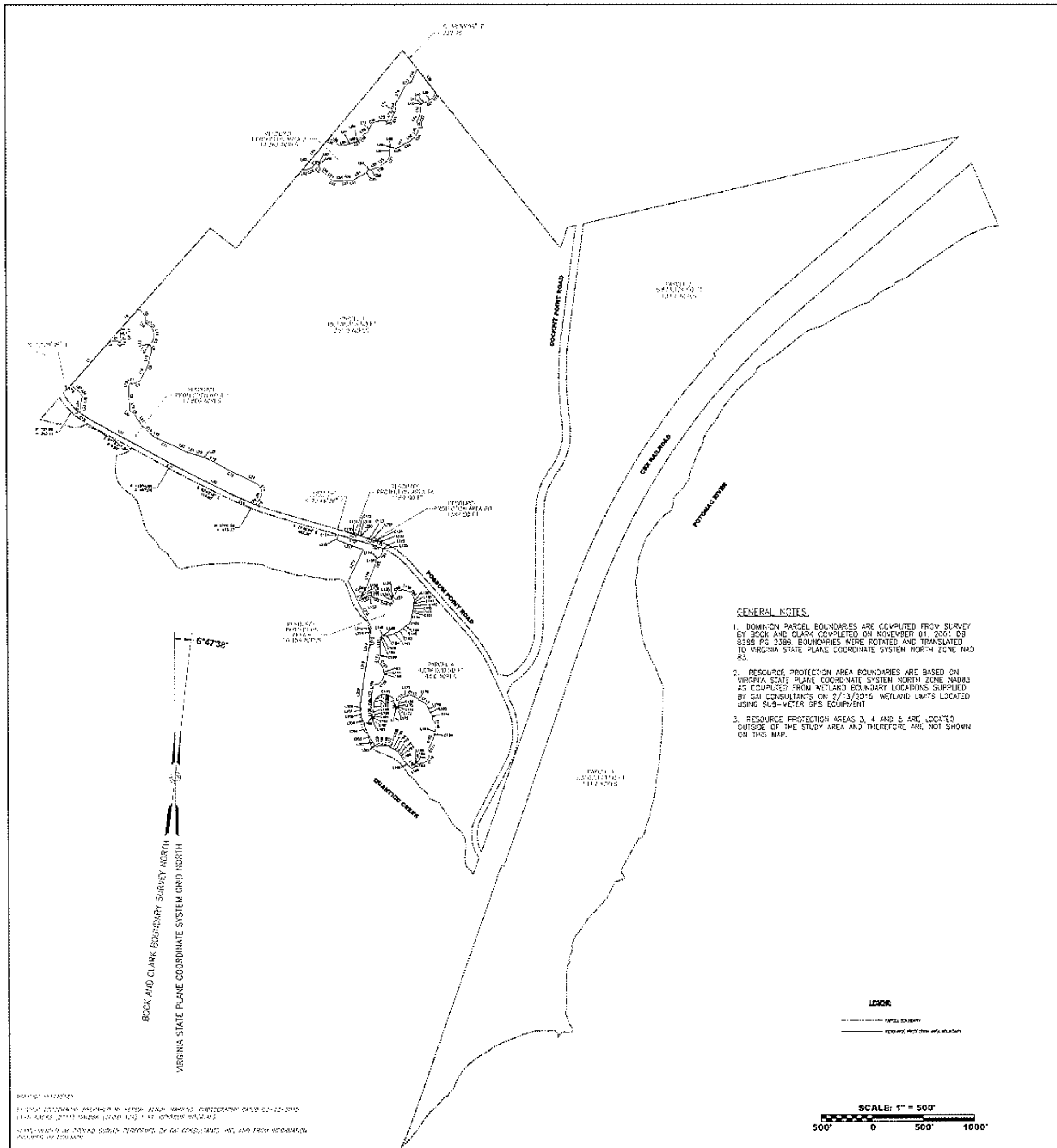
REVISION:

GAI FILE NUMBER: C150132-00-000-C-D1-060

ALT./CLIENT DRAWING NUMBER:

GAI DRAWING NUMBER: 061

PERMIT



GENERAL NOTES

1. DOMINION PARCEL BOUNDARIES ARE COMPUTED FROM SURVEY BY BOCK AND CLARK COMPLETED ON NOVEMBER 01, 2001 DB 3399 PG 2396. BOUNDARIES WERE ROTATED AND TRANSLATED TO VIRGINIA STATE PLANE COORDINATE SYSTEM NORTH ZONE NAD 83.

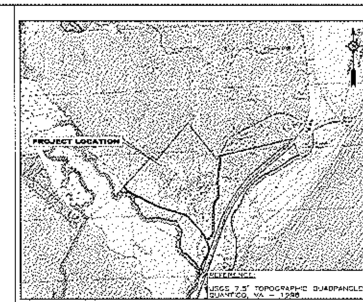
2. RESOURCE PROTECTION AREA BOUNDARIES ARE BASED ON VIRGINIA STATE PLANE COORDINATE SYSTEM NORTH ZONE NAD83 AS COMPUTED FROM WETLAND BOUNDARY LOCATIONS SUPPLIED BY GAI CONSULTANTS ON 2/13/2015. WETLAND LIMITS LOCATED USING SUB-METER GPS EQUIPMENT.

3. RESOURCE PROTECTION AREAS 3, 4 AND 5 ARE LOCATED OUTSIDE OF THE STUDY AREA AND THEREFORE ARE NOT SHOWN ON THIS MAP.

LINE	BEARING	DISTANCE
[illegible]	[illegible]	[illegible]

[illegible]	[illegible]	[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]



PROJECT LOCATION MAP
SCALE: 1"=2000'

NO.	DATE	DWN	CHK	APV	DESCRIPTION

REVISION RECORD

DRAWING TITLE
RESOURCE PROTECTION AREAS METES AND BOUNDS (1 OF 2)

PROJECT
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA

gai consultants

CLIENT
VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA

ISSUING OFFICE:

COMMONWEALTH OF VIRGINIA
DONALD F. CRANDER II
Lic. No. 2704
LAND SURVEYOR

DRAWN BY:	CHECKED BY:	APPROVED BY:
DOBBICR	KLAMUJR	KLAMUJR
DWG TYPE:	SCALE:	ISSUE DATE:
	AS SHOWN	11/13/2015

SHEET NO.: 62 OF 66
REVISION:
GAI FILE NUMBER: C150132-00-000-C-D1-062
ALT/CLIENT DRAWING NUMBER:
GAI DRAWING NUMBER: 062

PERMIT

DRAWING TITLE
RESOURCE PROTECTION AREAS METES AND BOUNDS (2 OF 2)

PROJECT
POSSUM POINT POWER STATION
COAL COMBUSTION RESIDUAL
SURFACE IMPOUNDMENT
CLOSURES
DUMFRIES, VA

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VIRGINIA ELECTRIC AND
POWER COMPANY
GLEN ALLEN, VA

NO.	DATE	DWN	CHK	APV	DESCRIPTION

REVISION RECORD

COMMONWEALTH OF VIRGINIA
DONALD F. CRAIGHEAD II
Lic. No. 2764
LAND SURVEYOR

DRAWN BY:	CHECKED BY:	APPROVED BY:
DOBBICR	KLAMUJR	KLAMUJR
DWG TYPE:	SCALE:	ISSUE DATE:
	AS SHOWN	11/10/2015

SHEET NO.: 63 OF 65

REVISION

GAI FILE NUMBER: C150132-00-000-C-D1-062

ALT./CLIENT DRAWING NUMBER:

GAI DRAWING NUMBER: 063

PERMIT

PRINCE WILLIAM COUNTY
Department of Development Services – Land Development Division

UNIT PRICE LIST
(Performance Bonds, Landscaping Escrows, Siltation & Erosion Control Escrows, and Floodplain Item Escrows)

Effective: August 1, 2015

Project Name: Possum Point Power Station Coal Combustion Residual Surface Impoundment Closures

PWC File #: SPR2016-00126S01 Date Prepared: October 15, 2015

NOTE: This form is to be used to estimate Performance Bond, Landscape Escrow, Siltation Erosion Escrow and Floodplain Item Escrow prices posted with Prince William County. These prices do not include items that are to be bonded separately with the Virginia Department of Transportation.

1. MOBILIZATION/DEMOBILIZATION OF CONSTRUCTION EQUIPMENT

Mobilization/Demobilization (Costing $10,000) @ Lump Sum $15,000.00 (min.)

2. STORM DRAINAGE

A. Structures

Quantity	Item	Price	Cost
	DI-3	@ $3,970 EA	
	DI-3	@ $4,220 EA	
	DI-4	@ $5,590 EA	
	MH-1	@ $2,580 EA	
	MH-2	@ $3,060 EA	
	SD-1	@ $5,900 EA	
	DI-7	@ $3,900 EA	
	DI-12	@ $4,200 EA	
		Subtotal for Structures:	

B. Concrete Pipe

Quantity	Item	Price	Cost
	12"Ø	@ $40 LF	
	15"Ø	@ $45 LF	
	18"Ø	@ $50 LF	
	21"Ø	@ $55 LF	
	24"Ø	@ $60 LF	
	27"Ø	@ $65 LF	
	30"Ø	@ $75 LF	
	33"Ø	@ $110 LF	
	36"Ø	@ $120 LF	
	42"Ø	@ $130 LF	
	48"Ø	@ $140 LF	
	54"Ø	@ $180 LF	
	60"Ø	@ $220 LF	
	66"Ø	@ $260 LF	
	72"Ø	@ $300 LF	
		Subtotal for Concrete Pipe:	

Subtotal for this page:

C. End Walls

Quantity	Item	Price	Cost
	12"Ø	@ $980 EA	
	15"Ø	@ $1,200 EA	
	18"Ø	@ $1,300 EA	
	21"Ø	@ $1,500 EA	
	24"Ø	@ $1,700 EA	
	27"Ø	@ $1,900 EA	
	30"Ø	@ $2,100 EA	
	33"Ø	@ $2,300 EA	
	36"Ø	@ $2,500 EA	
	42"Ø	@ $2,700 EA	
	48"Ø	@ $2,800 EA	
	54"Ø	@ $3,200 EA	
	60"Ø	@ $3,800 EA	
	66"Ø	@ $4,200 EA	
	72"Ø	@ $4,700 EA	
		Subtotal for End Walls:	

D. End Sections (ES-1)

Quantity	Item	Price	Cost
	12"Ø	@ $550 EA	
	15"Ø	@ $580 EA	
	18"Ø	@ $650 EA	
	21"Ø	@ $750 EA	
	24"Ø	@ $800 EA	
	27"Ø	@ $1,050 EA	
	30"Ø	@ $1,150 EA	
	33"Ø	@ $1,240 EA	
	36"Ø	@ $1,500 EA	
		Subtotal for End Sections ES-1:	

E. Corrugated Metal Pipe

Quantity	Item	Price	Cost
	12"Ø	@ $30 LF	
	15"Ø	@ $35 LF	
	18"Ø	@ $45 LF	
	24"Ø	@ $55 LF	
	30"Ø	@ $65 LF	
	36"Ø	@ $90 LF	
	42"Ø	@ $100 LF	
	48"Ø	@ $115 LF	
	54"Ø	@ $130 LF	
	60"Ø	@ $145 LF	
		Subtotal for CM Pipe:	

Subtotal for this page:

F. End Section (ES-2)

Quantity	Item	Price	Cost
	15"Ø	@ $335 EA	
	18"Ø	@ $360 EA	
	24"Ø	@ $420 EA	
	30"Ø	@ $590 EA	
	36"Ø	@ $950 EA	
	42"Ø	@ $1,180 EA	
	48"Ø	@ $1,440 EA	
		Subtotal for End Sections ES-2:	

G. AD N-12 (HDPE)

Quantity	Item	Price	Cost
	12"Ø	@ $30 LF	
	15"Ø	@ $40 LF	
	18"Ø	@ $60 LF	
	24"Ø	@ $70 LF	
	30"Ø	@ $80 LF	
	36"Ø	@ $90 LF	
	42"Ø	@ $100 LF	
	48"Ø	@ $120 LF	
	60"Ø	@ $150 LF	
		Subtotal for AD N-12 HDPE:	

Subtotal for this page:

H. Stormwater Management/BMP Facilities Cost Estimates Per Impervious Acre Treated (See Note 3)

Quantity	Item	Price	Cost
Non-Proprietary BMP (Engineer Estimate for all SWM)			
	Dry Retention Pond	By itemized cost	
	Dry Extended Detention Pond	By itemized cost	
	Wet Pond/Wetlands	By itemized cost	
	Bioswale	By itemized cost	
	Vegetated Grass Channel	By itemized cost	
	Micro-Bio-Retention (Raingarden)	By itemized cost	
	Infiltration Practices without Sand	By itemized cost	
	Infiltration Practices with Sand	By itemized cost	
	Filtering Practices with Sand Below Ground	By itemized cost	
	Filtering Practices with Sand Above Ground	By itemized cost	
	Permeable Pavement Level 2 Design	By itemized cost	
	Vegetated Roof Level 1 Design	By itemized cost	
	Vegetated Roof Level 2 Design	By itemized cost	
	Soil Compost Amendment	By itemized cost	
	Rooftop Impervious Surface Disconnection	By itemized cost	
	Sheet Flow to a Vegetated Filter Strip	By itemized cost	
Proprietary/Manufactured BMP-manufacturer's Certified Cost Plus Construction Cost			
	Aqua-Swirl® Stormwater Treatment System	By itemized cost	
	BaySeparator™	By itemized cost	
	Continuous Deflective Separator® (CDS)	By itemized cost	
	Downstream Defender®	By itemized cost	
	Hydroguard	By itemized cost	
	Stormceptor® MAX	By itemized cost	
	Stormceptor® OSR	By itemized cost	
	Stormceptor® STC	By itemized cost	
	StormPro	By itemized cost	
	Storm Water Quality Unit	By itemized cost	
	V2B1	By itemized cost	
	The Vortechs® System	By itemized cost	
	Aqua-Filter™ Stormwater Filtration System	By itemized cost	
	Storm Tech® Isolator Row™	By itemized cost	
	Up-Flo Filter® with CPZ Media	By itemized cost	
	The Stormwater Management StormFilter® with ZPG Media	By itemized cost	
	BayFilter™ Stormwater Cartridge System	By itemized cost	
	Filterra Bioretention Systems	By itemized cost	
	Jellyfish® Filter	By itemized cost	
	Modular Wetland System Linear (MWS-Linear)	By itemized cost	
	Perk Filter	By itemized cost	
	The Stormwater Management StormFilter® with Phosphosorb Media	By itemized cost	
Subtotal for Stormwater Management/BMP Facilities Cost Estimates Per Impervious Acre Treated:			

Subtotal for this page:

I. Miscellaneous Stormwater Management:

Quantity	Item	Price	Cost
	Seed, Fertilizer & Mulch ($200 Min.)	@ $2 SY	
	Sod	@ $7 SY	
	Hydraulic Cem. Conc. - 4" depth	@ $6.00 SF	
	Bituminous Concrete -4" depth	@ $5.00 SY	
	Rip-Rap	@ $7.00 SF	
	Grouted Rip-Rap	@ $8.00 SF	
	Erosion Control Stone (EC-1)	@ $110 TON	
	#57 - Coarse Aggregate	@ $26 TON	
	4' High Chain Link Fence (#9 gauge or better, including braces, end posts and gate)	@ $24 LF	
	6' High Chain Link Fence (#9 gauge or better, including braces, end posts and gate)	@ $37 LF	
	SWM Sign (WATER RISES RAPIDLY) (Minimum 3 signs per Facility)	@ $300 EA	
	Access Road	By itemized cost	
		Subtotal for Miscellaneous Stormwater Management:	

J. Miscellaneous Drainage Items

Quantity	Item	Price	Cost
	Box Culvert	@ $722 CY of conc.	
	Energy Dissipater	@ $2,951 EA	
	Wing Walls	@ $600 CY of conc.	
Ditches			
	Roadside standard ditches (Seed, fertilize and mulch)	@ $7.00 LF	
	Sod Ditches	@ $9.00 LF	
	Paved Ditches	@ $8.00 SF	
	Filter Cloth Fabric & Gabion Stone	@ $14 SF	
	Rip-rap	@ $6.00 SF	
	Grouted Rip-rap	@ $8.00 SF	
	Paved Flume	@ $10.00 SF	
	Flush the Drainage System	@ $250/Hr (Min. 8 Hrs)	
		Subtotal for Miscellaneous Drainage Items:	

Subtotal for this page:

3. CONSTRUCTION WITHIN THE PUBLIC RIGHT-OF-WAY AND/OR PRIVATE INGRESS/EGRESS EASEMENTS

A. Site Work

Quantity	Item	Price	Cost
	Clear & Grub	@ $11,860	
	Excavation	@ $26 CY	
	Embankment** (cut and fill)	@ $10 CY	
	Embankment (haul off)	@ $36 CY	
	Final Grading	@ $10,000 AC	
	Rock Excavation	@ $64 CY	
	Slope Stabilization - Hydroseeding (3:1 or flatter) $1,000 Min.	@ $1 SY	
	Slope Stab. - Jute Mesh, Matting, Blankets, etc (Between 2:1 to 3:1) $200 Min.	@ $6 SY	
	Slope Stab. - Sod (Between 2:1 to 3:1) $200 Min.	@ $8 SY	
	Steep Slopes (Grading and Stabilization with Jute Mesh, Netting, Blankets, etc.)	@ 17 SY	
		Subtotal for Site Work:	

B. Subgrade, Subbase and Base Course Items

Quantity	Item	Price	Cost
	Subgrade preparation (Subbase and base course)	@ 2 SY	
	Aggregate (21A/21B)	@ $2.50 SY per Inch Depth	
	Bituminous Concrete	@ $5.50 SY per Inch Depth	
	Reinforced Concrete Pavement	@ $15.50 SY per Inch Depth	
	Gravel Shoulders (4" Depth)	@ $8.50 SY (4" Depth)	
	Soil Cement Stabilization (4%)	@ $20.50 SY (6" Depth)	
	Lime Stabilization (10%)	@ $15 SY (6" Depth)	
	Cement Treated Aggregate	@ $5 SY per Inch Depth	
Underdrains			
	UD-1	@ $16 LF	
	UD-2	@ $18 LF	
	UD-3	@ $19 LF	
	UD-4	@ $21 LF	
Subtotal for Subgrade, Subbase, Base Course Items & Underdrains (Public):			

Subtotal for this page:

NO.	DATE	DWN	CHK	APV.	DESCRIPTION

REVISION RECORD

DRAWING TITLE: UNIT PRICE LIST (SHEET 1 OF 2)

PROJECT: POSSUM POINT POWER STATION COAL COMBUSTION RESIDUAL SURFACE IMPOUNDMENT CLOSURES DUMFRIES, VA

gai consultants

CLIENT: VIRGINIA ELECTRIC AND POWER COMPANY GLEN ALLEN, VA

ISSUING OFFICE: Richmond | 4198 Cox Road, Suite 114, Glen Allen, VA 23060

JOHN R. KLAMUT Lic. No. 045892 11/18/2015

DRAWN BY	CHECKED BY	APPROVED BY
LEIDYJM	KNOEXW	KLAMUJR
DWG TYPE	SCALE	ISSUE DATE
	AS SHOWN	11/18/2015

SHEET NO.: 64 OF 65 REVISION

GAI FILE NUMBER: C150132-00-000-C-D1-064

ALT./CLIENT DRAWING NUMBER:

GAI DRAWING NUMBER: 064

PERMIT

C. Entrances and Pipe Stems

Quantity	Item	Price	Cost
	DE-1	@ $1,800 EA	
	DE-2	@ $1,950 EA	
	DE-3	@ $2,000 EA	
	DE-4	@ $2,000 EA	
	PP-1 (1 lot)	@ $1,800 EA	
	PP-1 (2 - 5 lots)	@ $2,000 EA	
	PP-2 (1 lot)	@ $1,700 EA	
	PP-2 (2 - 5 lots)	@ $1,800 EA	
	CG-9D or equal: 30' Width	@ $5,000 EA	
	CG-9D or equal: 40' Width	@ $6,500 EA	
	CG-39A or equal: 30' Width	@ $4,120 EA	
	CG-39A or equal: 40' Width	@ $5,300 EA	
	CG-11 Concrete Entrance	@ $5,000 EA	
	Valley Gutter	@ $55 SY	
	Pipestem Driveway - 18' (1 lot)	@ $55 LF	
	Pipestem Driveway - 18' (2-5 lots)	@ $70 LF	
		Subtotal for Entrance and Pipe Stems:	

Subtotal for this page:

D. Miscellaneous Construction Items

Quantity	Item	Price	Cost
	Sidewalk (5' Width)	@ $34 LF	
	Header Curb (CG-2/CG-3)	@ $20 LF	
	Curb & Gutter	@ $25 LF	
	CG-12 (Truncated Dome)	@ $2,000 EA	
	Bicycle Trail/Walkway	@ $9 SY	
	Raised Concrete Median (MS-1A)	@ $70 SY	
	Trail (Wood Chip)	@ $19 SY	
	Trail (Stone Dust)	@ $19 SY	
Retaining Walls:			
	Timber	@ $29 SF	
	Crib	@ $38 SF	
	MSE/Geogrid	@ $42 SF	
	Gravity Wall	@ $62 SY	
	Excavation for tiebacks in walls in cut areas	@ $25 CY	
	Anti-Graffiti Paint (Concrete retaining walls only-treatment/sealant)	@ 15 SF (Min. $2,500)	
	Guardrail	@ $39 LF	
	GR-7 NCHRP 350	@ $2,686 EA	
	GR-9	@ $2,618 EA	
	Address Sign (Entrance to Pipestems)	@ $398 EA	
	Street Name Sign	@ $410	
	Traffic Control Sign	@ $392	
	Bus Stop Sign	@ $342	
	Bus Shelter	@ $17,284	
	Traffic Signal (Lump Sum)	@ $(Lump Sum)	
	HC Parking Space Sign	@ $649 EA	
	Bike Rack	@ $305 EA	
	Roadside Delineators (ED-1)	@ $64 EA	
	Hand Rail (HR-1)	@ $102 LF	
	Pavement Marking (Paint)	@ $2 SF	
	Pavement Marking (Thermoplastic)	@ $6 SF	
	Traffic Barricade (TB-1)	@ $1,500 EA	
	Street Lighting	@ $5,500 EA	
	Utilities Relocation	(Min. $40,000) (lump sum or provide an estimate from utility company)	
	VDOT Street Acceptance Package	@ $5,000	
	P.E. Certified "As-Built" Plans	Lump Sum (Min. $12,000)	
		Subtotal for Miscellaneous Construction Items:	

Subtotal for this page:

4. SANITARY SEWER & WATER LINE CONSTRUCTION

Quantity	Item	Price	Cost
	Fire Hydrant Assembly	@ $5,000 EA	
	Central Sewer Lift/Pump Station Construction	@ (Lump Sum)	

Water Main (Exclusive of Fire Hydrant)

Quantity	Item	Price	Cost
	4"Ø DIP	@ $48 LF	
	6"Ø DIP	@ $60 LF	
	8"Ø DIP	@ $72 LF	
	12"Ø DIP	@ $96 LF	
	16"Ø DIP	@ $120 LF	
	18"Ø DIP	@ $126 LF	
	4"Ø or 6"Ø RW Valve (with accessories)	@ $800 EA	
	8"Ø or 12"Ø RW Valve (with accessories)	@ $2,600 EA	
	16"Ø or 24"Ø RW Valve (with accessories)	@ $5,500 EA	
	Standard Meter Crock & Appurtenances (Angle valve, backflow preventer, yoke, frame & cover, and service line)	@ $2,000 EA	
	Meter Vault & Appurtenances (3" meters & larger)	@ $20,500 EA	
	Water Main Blow-off Assembly	@ $2,500 EA	
	Air Release Assembly	@ $3,500 EA	
	Dead End Anchor System	@ $7,500 EA	
		Subtotal for Water Main:	

Subtotal for this page:

Sanitary Sewer Pipe Line (Exclusive of Manhole Structures)

Quantity	Item	Price	Cost
	1.5"Ø thru 4"Ø LPFM (Low Pressure Force Main System)	@ $25 LF	@ $25 LF
	8"Ø PVC	@ $65 LF	@ $65 LF
	8"Ø DIP	@ $75 LF	@ $75 LF
	10"Ø PVC	@ $80 LF	@ $80 LF
	10"Ø DIP	@ $90 LF	@ $90 LF
	12"Ø PVC	@ $140 LF	@ $140 LF
	12"Ø DIP	@ $150 LF	@ $150 LF
	15"Ø PVC	@ $185 LF	@ $185 LF
	4' Dia. Sanitary Sewer Manhole	@ $10,000 EA	@ $10,000 EA
	5' Dia. Sanitary Sewer Manhole	@ $10,000 EA	@ $10,000 EA
	Street Manhole Frame & Cover Assembly (Including rain bowl & chimney seal)	@ $1,000 EA	@ $1,000 EA
	Easement Manhole Frame & Cover Assembly (Including chimney seal)	@ $1,000 EA	@ $1,000 EA
	Abandonment of Manhole	@ $250 VF	@ $250 VF
	4"Ø PVC Lateral (including clean-out stack)	@ $35 LF	@ $35 LF
	4"Ø DIP Lateral (including clean-out stack)	@ $45 LF	@ $45 LF
	6"Ø PVC Lateral (including clean-out stack)	@ $55 LF	@ $55 LF
	6"Ø DIP Lateral (including clean-out stack)	@ $65 LF	@ $65 LF
	LPFM Flushing Station	@ $2,500 EA	@ $2,500 EA
	Sewerage Air Release/Vacuum Breaker Assembly	@ $3,500 EA	@ $3,500 EA
	Steel Casing	@ $500 LF	@ $500 LF
	Grease Trap (500 gal. minimum)	@ $4,500 EA	@ $4,500 EA
		Subtotal for Sanitary Sewer Pipe:	

Note: For sizes larger than 15"Ø, add $4.00 per inch increase in diameter.

Subtotal for this page:
TOTAL CONSTRUCTION COST:
(Pages 1 through 10)

5. MISCELLANEOUS COSTS

A. Administrative Cost - 10% of the total construction cost, not to exceed $50,000
B. Inflation Cost - Compounded annually at 3.0% per year of the total Construction Cost
TOTAL PERFORMANCE BOND AMOUNT:

6. FLOODPLAIN ITEMS ESCROW

Quantity	Item	Price	Cost
	LOMR	$ 15,000.00	
	Elevation Certificate	$ 800.00	
	LOMC (SF Detached)	$ 1,500.00	
Stream Restoration			
	Stream Restoration	By itemized cost	

TOTAL FLOODPLAIN ITEMS ESCROW:

7. LANDSCAPING ESCROW

A. Deciduous Trees

Quantity	Item	Price	Cost
	5' - 6'	@ $165 EA	
	1" - 1½" or 1½ - 2"	@ $165 EA	
	2" - 2½" or 2½ - 3"	@ $250 EA	
	3" - 3½" or 3½ - 4"	@ $350 EA	
		Subtotal for Deciduous Trees:	

B. Evergreen Trees

Quantity	Item	Price	Cost
	5' - 6'	@ $125 EA	
	6' - 7'	@ $175 EA	
	7' - 8'	@ $309 EA	
	8' - 10'	@ $408 EA	
		Subtotal for Evergreen Trees:	

C. Shrubs

Quantity	Item	Price	Cost
	18" - 24"	@ $45 EA	
	24" - 30"	@ $55 EA	
		Subtotal for Shrubs:	

D. Ornamental

Quantity	Item	Price	Cost
	1 Gal. (#1)	$ 10.00	
	2 Gal. (#2)	$ 22.00	
	3 Gal. (#3)	$ 30.00	
		Subtotal for Ornamentals:	

E. Perennial

Quantity	Item	Price	Cost
	18" - 24"	$ 9.00	
		Subtotal for Perennial:	

F. Reforestation

Quantity	Item	Price	Cost
	# of Acres	@ $13,200 AC	
		Subtotal for Reforestation:	

TOTAL LANDSCAPE ESCROW AMOUNT:

8. SILTATION AND EROSION CONTROL ESCROWS

Quantity	Item	Price	Cost
850	Diversion Dike	@ $ 6 LF	5,100
1	Cleaning out SWM Facilities, Silt Traps, and Silt Basins	@ $500/Ac. Lump Sum (Min $20,000) or actual cost as provided by engineer to the satisfaction of the plan reviewer	20,000
	Silt Fence	@ $8 LF	
6,030	Super Silt Fence	@ $20 LF	120,600
	Sod	@ $8 SY	
125,840	Seed, Fertilizer & Mulch	@ $2 SY ($200 Min.)	251,680
	Steep Slopes (Seeding and Stabilization with fabrics, netting, blankets, etc.)	@ $15 SY	
	Coarse Aggregates (#1 or #57)	@ $23 Ton	
	Inlet Protection	@ $150 EA	
	Check Dam	@ $165 EA	
	Temp. Construction Entrance	@ $1,000 EA	
	Wash Rack	@ $2,000 EA	
	Temp. Sediment Trap	$ 1,000.00	
		$ 1,500.00	
		$ 2,000.00	
1	Temporary Sediment Basin	By itemized cost	50,000
	Channel Diversion	By itemized cost	
	6' Chainlink Safety Fence	@ $20 LF	
	4' Plastic Orange Safety Fence	@ $3 LF	
	Yard inlet refurbishment	@ 250 EA Single Family Lot	
	Stockpile Removal (Quantity based on policy)	$ 25.00 CY	
26	Removal of Erosion Control Measures	@ 500	13,000
	Level Spreader	By itemized cost	
		Total Cost:	460,380
		Administrative Cost (10% of Total Cost):	46,038
		TOTAL SILTATION & EROSION CONTROL ESCROW AMOUNT:	506,418

Minimum acceptable amount for Siltation and Erosion Control Escrow is $2,000.00

I hereby certify that the above is my best estimate of the quantities and current cost of bondable improvements, landscaping items, Siltation & Erosion Control Escrow and floodplain items in this subdivision or site plan.

Preparer's Signature ______________________ Telephone # ______________________

Name (Print) ______________________ Company or Firm ______________________

Note: The CCR impoundments are regulated by the VDEQ and financial assurance for the closure of the CCR impoundments is required by the pending VDEQ Solid Waste Permit for the CCR impoundment closures. Therefore, only areas outside of the CCR impoundments are included in this estimate. These areas include the borrow areas outside of CCR impoundments shown on the Plans.

NOTES:

1. For items identified with "*" the quantity for the embankment material is the net difference of total fill material needed and cut material available at the project site, if excavated or cut material is suitable for embankment.
2. The excavation and embankment costs include necessary grading, spreading and/or compaction of soil in accordance with County and State Standards and Specifications.
3. The unit cost for each of the items in the Unit Price Lists is the installation cost which includes factors such as materials, excavation, bedding, backfilling, compactions, form work, etc.
4. Inflation has been calculated based on Northern Virginia Consumer Price Index of the Washington D.C. area provided by the Bureau of Labor and Statistics.
5. Whoever certifies the site development plans must also certify the total cost of the bonded items, landscaping escrow and siltation and erosion control escrow and must sign of "Preparer's Signature" on page 10 of this form.
6. Floodplain Items Escrow not to be part of Bond/Escrow reduction.

DRAWING TITLE: UNIT PRICE LIST (SHEET 2 OF 2)

PROJECT: POSSUM POINT POWER STATION COAL COMBUSTION RESIDUAL SURFACE IMPOUNDMENT CLOSURES DUMFRIES, VA

gai consultants

CLIENT: VIRGINIA ELECTRIC AND POWER COMPANY GLEN ALLEN, VA

NO.	DATE	DWN.	CHK.	APV.	DESCRIPTION

REVISION RECORD

DRAWN BY	CHECKED BY	APPROVED BY
LEIDYJM	KINDEKW	XLAMIJR
DWG TYPE	SCALE	ISSUE DATE
	AS SHOWN	11/18/2015

SHEET NO. 65 OF 65

GAI FILE NUMBER: C150132-00-000-C-D1-064

ALT./CLIENT DRAWING NUMBER

GAI DRAWING NUMBER: 065

PERMIT

APPENDIX B
Drainage and Erosion and Sediment Control Calculations

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Hydrologic and Hydraulic Calculation Booklet

Virginia Electric and Power Company
Possum Point Power Station
Coal Combustion Residual Surface Impoundment Closures
Dumfries, Virginia

GAI Project Number: C150132.00
October 2015

Dominion

Prepared by: GAI Consultants, Inc.
Richmond Office
4198 Cox Road, Suite 114
Glen Allen, Virginia 23060-3328

Prepared for: Virginia Electric and Power Company
5000 Dominion Boulevard
Glen Allen, Virginia 23060-3308

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1.0 Introduction

This Hydrologic and Hydraulic (H&H) Calculation Booklet was prepared on behalf of Virginia Electric and Power Company d/b/a Dominion Virginia Power (Dominion) by GAI Consultants, Inc. (GAI) in support of the Prince William County (PWC) Site Plan for the closure of three inactive Coal Combustion Residual (CCR) Surface Impoundments, located at Dominion's Possum Point Power Station in Dumfries, Virginia (VA). This document and the calculations provided in the appendices are also intended to support a Closure Plan, submitted to the VA Department of Environmental Quality Solid Waste Management Group, as well as Dam Permit Modification Plans, submitted to the VA Department of Conservation and Recreation (VDCR) for each of the existing regulated impoundments proposed to be closed. Additionally, the VA Department of Transportation (VDOT) will be provided with a copy of the PWC Site Plan for review due to the projects proximity and potential impacts to Possum Point Road. This calculation book may be updated as needed to address the specific submittal requirements of each agency.

The calculations presented herein were prepared in accordance with the PWC Design and Construction Standards Manual, VA Solid Waste Management Regulations (VSWMR), and VDCR requirements.

2.0 Facility Background and Existing Conditions

Dominion currently maintains three inactive CCR Surface Impoundments (Ponds), located at the Possum Point Power Station in PWC, VA. The two northern-most ponds (D and E) are hydraulically connected and are analyzed as a single system (Pond D-E). The southern ponds (A, B, and C) operate independently of Pond D-E and the analysis is included as such.

2.1 Ponds D and E

Ponds D and E are both permitted impounding structures (dams), regulated by the VDCR.

Pond D, which is located upslope from Pond E and is designed to discharge into Pond E, has a contributory drainage area of approximately 115 acres. Historic operation of Pond D has resulted in a pool elevation which is significantly below the elevation of the principal spillway. As such, existing discharge from Pond D into Pond E, even during design storm events, is 0 cubic feet per second (cfs).

Pond E is designed to receive inflow from Pond D, from its own contributory drainage area of approximately 104 acres, and from the pumped discharge of multiple power station operations. The contributions of the pumped discharges are small in comparison to stormwater flows and the Station has the ability to stop the discharges as necessary, such as during significant rainfall events. As such, these flows are not included in the H&H design presented in these calculations.

The permitted discharge from the Pond D-E system is Outfall 005, located in the northwestern corner of Pond E. This outfall discharges into a tributary of Quantico Creek. The Pond E water surface elevation has been typically maintained at the crest of the principal spillway, such that all flow entering the pond would be discharged.

2.2 Pond A, B, and C

Pond A, B, and C is a permitted impounding structure (dam), regulated by the VDCR. The dam that forms Pond A, B, and C is considered a single structure for VDCR dam permitting purposes. However, there are three distinct areas behind the dam that are referred to as Pond A, Pond B, and Pond C.

Although its embankment is still in place, Pond A, B, and C essentially have no storage capacity available, as CCR material, soil, and vegetation has filled in the ponds near to their crest. An outfall structure exists in the northwestern corner of Pond C which discharges through a riser to Outfall S104 and directly into Quantico Creek. Ponds A and B drain to the Pond C outfall structure in the existing condition.

3.0 Design Criteria and Methodology

Developing a closure plan for the ash ponds required adoption of multiple design criteria from regulating agencies. This section summarizes the design criteria selected for specific facets of the closure design.

3.1 Erosion and Sediment Control

Erosion and sediment control (E&SC) Best Management Practices have been selected and designed per the requirements of the VA E&SC Handbook. Additionally, to meet the requirements of the VSWMR, all conveyances have been designed to convey the 25-year, 24-hour storm.

- All site conveyance channels are designed for capacity and stability, considering the 25-year, 24-hour storm event for both un-vegetated (temporary) and vegetated (permanent) conditions.
- Temporary Sedimentation Basins are designed to provide 134 cubic yards of storage per acre of contributory drainage area and spillways have been provided to convey the 25-year, 24-hour storm event. Temporary Sedimentation Basins will remain in service until vegetation has been established throughout the site.
- All new on-site culverts are designed to convey the 25-year, 24-hour storm event without overtopping of the travel way.
- All outlet protection and energy dissipation structures are designed to provide a stable outlet for the 25-year, 24-hour storm event.

3.2 Stormwater Quantity Management

The Pond D-E system, as well as Pond A, B, and C, each discharge into tidal floodplains, within which water levels are governed by backwater from the Potomac River. Due to this discharge condition, and per discussion with PWC representatives, stormwater quantity control measures (i.e. stormwater basins) are not required to reduce the peak rate of flow or runoff volume in the final closure condition.

All channels which convey stormwater from within the closure sites and into the tidal floodplains are vegetated with a maximum slope of one percent, and include rock check dams to reduce erosion potential for the 25-year, 24-hour storm event.

3.3 Stormwater Quality Management

Each of the closure sites will be fully revegetated with a turf grass that will be maintained in the post closure condition. As such, the site will be in compliance with the PWC water quality criteria, considering the VA Runoff Reduction Method.

3.4 Floodplain Management

As previously stated, the closed ponds are proposed to discharge into tidal floodplains. Pond A, B, and C discharge directly into Quantico Creek, and as such, will have no impact on the Federal Emergency Management Agency (FEMA) regulated 100-year water surface elevation. The Pond D-E system discharges into a tributary of Quantico Creek just upstream of two culverts under Possum Point Road. Although the floodplain at this location is also governed by backwater from the Potomac River, the potential impact of the increased runoff rates and volumes associated with the site development on the hydraulic performance of the culverts are evaluated for consistency with FEMA floodplain regulations. Because the Pond D-E system discharges into a detailed FEMA study area, no increase in the 100-year water surface elevation is permitted.

3.5 Dam Permit Requirements

The only pond that will remain classified as a dam under VDCR regulation in the post closure condition will be Pond D. Through correspondence with the VDCR, the adopted design criteria for the facility is that hydraulic structures which would impact the integrity of the dam embankment must be designed to convey the Probable Maximum Flood (PMF).

The only hydraulic structure that is anticipated to impact the integrity of the embankment is the open channel that conveys storm water from Pond D (closed condition) into Pond E (closed condition). This channel is designed for capacity and stability considering the PMF event. The channel conveys the PMF flow beyond the limit of fill for the Pond D embankment. Downstream of this point, channels, culverts, and other structures are designed for the 25-year event.

During the closure of Pond D, the dam embankment crest will be lowered from elevation 150 feet to elevation 119 feet. This reduction in embankment height will occur prior to construction of the open channel to convey flow to Pond E, and as such, Pond D will not have a spillway. The attached calculations show that the storage volume provided in Pond D, below elevation 119 feet, is sufficient to completely store runoff volume generated from the PMF, maintaining the stability of the dam embankment during the construction phase.

3.6 Possum Point Road Culvert Requirements

As described under the Floodplain Management criteria section, the Pond D-E system discharges just upstream of two culverts under Possum Point Road. These culverts are operated and maintained by VDOT, and as such, the culvert's performance in the post development condition was evaluated. The adopted design criterion, per the VDOT Drainage Manual is that:

- The culverts must maintain the ability to pass the 10-year, 24-hour storm event without inundating the travel way.

This criterion is in addition to evaluation of the 100-year event, as described previously and also as required by VDOT.

4.0 Run-On and Runoff Control Systems

The run-on and runoff controls shown on the plans were designed considering the "during construction" phase as well as the post construction condition. Construction phasing plays a significant role in the site development and design of the runoff controls. Annotated versions of the construction sequence of each pond, as it relates to the H&H design, are included in the following sections.

4.1 Ponds D and E

The Pond D-E system closures are integrated, and the H&H analyses are dependent on the phasing of the closure. All CCR material is to be removed from Pond E and placed in Pond D where the material will be lined and capped. The following general construction sequence has been assumed for the H&H analyses:

1. Pond E will be decanted through its existing permitted outlet. Water unable to be decanted through the outlet structure is pumped into Pond D. Pumping operations will be the responsibility of the contractor. H&H features are not required for this phase.
2. Runoff and water pumped into Pond D will be stored behind the existing Pond D embankment. The stored water will be treated and pumped to an outfall permitted by the Station's VA Pollutant Discharge Elimination System (VPDES) Permit. Pumping operations will be the responsibility of the contractor. H&H features are not required for this phase.

3. CCR material from dewatered Pond E will be mechanically removed from Pond E and transported to Pond D. Pond E direct runoff will be stored behind the existing Pond E embankment. The stored water will be treated and pumped to an outfall permitted by the Station's VPDES Permit. Pumping operations will be the responsibility of the contractor. H&H features are not required for this phase.
4. Once all CCR material has been removed from Pond E, the collected runoff water will be permitted to discharge into the tributary of Quantico Creek, provided that properly designed E&SCs are provided. H&H features include stormwater conveyance channels, a sedimentation basin within the existing Pond E footprint, and associated erosion protection measures.
5. Grading of Pond E will continue and the runoff will be controlled by the designed measures prior to discharge into the tributary of Quantico Creek. Grading within Pond D will also continue (including reduction in the height of the embankment), however water will not be permitted to discharge into the tributary until all CCR material has been capped. H&H features include stormwater conveyance channels within Pond D. The channels will be constructed as closing and capping of the CCR material progresses, but the channels will not be permitted to discharge beyond the limits of the Pond D embankment. The water may be pumped to an outfall permitted by the Station's VPDES Permit.
6. After vegetation has become established within Pond E and the CCR material in Pond D has been capped, the embankment between Pond D and Pond E will be breached and the runoff will be permitted to discharge into the tributary of Quantico Creek, provided that properly designed E&SCs are present. H&H features include a temporary sediment basin, stormwater conveyance channels from Pond D into Pond E and culverts to convey this discharge beneath an existing access road.
7. Once both ponds are fully vegetated, the temporary sediment basin may be removed and the conveyance channels will be extended to discharge directly into the tributary of Quantico Creek.

4.2 Pond A, B, and C

All CCR material will be removed from Pond A, B, and C during closure and trucked to an offsite disposal facility or to Pond D where the material will be lined and capped. The following general construction sequence has been assumed for the H&H analyses:

1. Removal of the CCR material will be performed such that runoff during construction will be stored behind the existing embankment. The stored water will be pumped to an outfall permitted by the Station's VPDES Permit. Pumping operations will be the responsibility of the contractor. H&H features are not required for this phase.
2. Once all CCR material has been removed from the pond, the runoff water will be permitted to discharge into Quantico Creek, provided that properly design E&SCs are present. It is proposed that two sedimentation basins will be used to treat the water prior to discharge.
3. Once vegetation has been established within the closure site, the temporary sedimentation basins will be removed and the stormwater conveyance channels will be designed to discharge directly into Quantico Creek.

5.0 Calculations

Supporting calculations for the controls shown on the plans and described above are included as Appendices A through E.

APPENDIX A
Site Hydrologic Calculations

APPENDIX A

TABLE OF CONTENTS:

SHEET*

*Appendix sheet numbers correspond to red numbers in the upper right hand corner of each page.

SUBJECT POSSUM POINT CCR POND CLOSURES

SITE HYDROLOGIC ANALYSES

BY SCHELAB DATE 06/28/2015 PROJ. NO. C150132.00

CHKD. BY BERKEME DATE 07/9/2015

gai consultants

INTRODUCTION:

In order to design stormwater conveyance and storage features that will be used throughout the closure of the three CCR ponds at the Possum Point Power Station, hydrologic analyses were performed to develop peak runoff rates and volumes for various phases of construction. This calculation summarizes the methods used to develop the design values.

METHODOLOGY:

Drainage areas to the site features requiring design and evaluation were delineated using project mapping. The Natural Resources Conservation Service (NRCS) TR-55 method was utilized to estimate peak rate of runoff and associated runoff volume. For overall site modeling, the TR-55 method was executed through the U.S. Army Corps of Engineers Program HEC-HMS, Version 4.0. For the design of some individual hydraulic features, Hydraflow Hydrographs, Version 10 was utilized. These calculations are included in the calculation Appendix within which they are applied. United States Geological Survey (USGS) mapping was used to quantify existing land use, and soil information was obtained through the U.S. Department of Agriculture's (USDA) online web soil survey. Rainfall data was obtained through the National Oceanic and Atmospheric Association's (NOAA) Atlas 14, for coordinates near the Project Site.

Ponds D and E are modeled within a single HEC-HMS basin and operate as a connected hydraulic system. Pond ABC operates independently of the others, and thus is modeled under a separate basin. Both basin models are presented in this calculation set.

REFERENCES

1. TR-55, Urban Hydrology For Small Watersheds, Natural Resources Conservation Services, June 1986.
2. NOAA Atlas 14, Volume 2, Version 3, Point Precipitation Frequency Estimates for Coordinates Near Dumfries, Virginia, March, 2015.
3. Possum Point Power Station Ash Pond D Final Design Report Submitted to State, October 1986.
4. Dam Breach Analysis and Emergency Preparedness Plan Supporting Documentation, Possum Point Power Station Ash Pond E, April 2011.

ATTACHMENTS:

1. Drainage Area Maps
2. Soil Data
3. Curve Number and TOC Calculations
4. NOAA Rainfall Data
5. PMP Evaluation

SUBJECT POSSUM POINT CCR POND CLOSURES
SITE HYDROLOGIC ANALYSES
BY SCHELAB DATE 06/28/2015 PROJ. NO. C150132.00
CHKD. BY BERKEME DATE 07/9/2015

gai consultants

ATTACHMENTS CONT.

6. HEC-HMS Input
7. HEC-HMS Output

Draiange Areas:

Refer to Attachment 1 for existing and proposed drainage from each of the pond closure sites.

Curve Numbers:

Curve numbers were selected using engineering judgement based on guidance provided in Reference 1. Refer to Attachment 2 for soil data and Attachment 3 for composite curve number calculations.

The following curve numbers were used to represent the site conditions currently present or anticipated to occur during closure or post closure:

Existing Conditions:		
Water	=	98
Gravel Roads	=	89
Paved Road	=	91
Woods (A type Soil)	=	36
Woods (B type Soil)	=	60
Woods (C type Soil)	=	70
Woods (D type Soil)	=	79
Meadow (A type Soil)	=	30
Meadow (B type Soil)	=	58
Meadow (C type Soil)	=	71
Meadow (D type Soil)	=	78

During Construction Condition (Disturbed) Conditions:		
Bare Soil (B type Soil)	=	82
Bare Soil (C type Soil)	=	87
Bare Soil (D type Soil)	=	89

Note that the soil type used in the analysis depended on the soil type of the borrow area that is intended to be used to close each pond.

Post Construction (Final) Conditions:		
Re-vegetated (B type Soil)	=	58
Re-vegetated (C type Soil)	=	71
Re-vegetated (D type Soil)	=	78

Note that the soil type used in the analysis depended on the soil type of the borrow area that is intended to be used to close each pond.

Time of Concentration:

Time of concentration (TOC) flow paths were estimated using the methods provided in TR-55, incorporating sheet flow, shallow concentrated flow, and channel flow segments. Slopes and channel dimensions were estimated from the project mapping which was developed from survey information. Refer to Attachment 3 for Time of Concentration calculations. A minimum TOC of 6 minutes was used.

The HEC-HMS program requires lag time to be input, which was calculated as 60% of the calculated time of concentration.

Rainfall Data:

Refer to Attachment 4 for NOAA precipitation estimates for the site. These values are summarized below:

2-year, 24-hour event	=	3.12 in
10-year, 24-hour event	=	4.84 in
25-year, 24-hour event	=	6.06 in
100-year, 24-hour event	=	8.35 in

Note that the probable maximum precipitation (PMP) is computed in a separate calculation set, included as Attachment 5

HEC-HMS Modeling

The drainage area, runoff curve number, and lag time for each contributing watershed were input into the HEC-HMS program for each of the design conditions. Refer to Attachment 6 for schematics of each site condition that was modeled. Below are brief descriptions of each. Detailed design of conveyance channels, culverts, and sediment basins, along with specific HMS modeling for these features are included in separate calculation sets.

<u>Existing Conditions:</u>
For Ponds D and E, the existing conditions HEC-HMS model incorporated the hydraulic performance of the ponds. This included developing stage-storage curves for the ponds as well as stage-discharge curves for the pond outlet structures. The stage-storage curves were developed from the bathymetric survey data collected for the project and are included in Attachment 6. Stage-

discharge curves for the outlet structures were taken from previous calculations developed for each of the ponds (References 3 and 4) and are also included in Attachment 6. Initial water surface elevations for each of the ponds were based on survey data taken at the start of the Project and on historical operation of the facilities.

Pond D Starting Water Surface Elevation	=	102.5 feet
Pond E Starting Water Surface Elevation	=	38.3 feet

All existing flow through Ponds D and E occurs through the Pond E riser to Outfall 005.

Pond ABC is nearly filled completely with CCB material, soil, and vegetation and as such, routing through its outlet structure has not been performed.

During Construction Conditions

Two separate conditions are considered for Ponds D and E during construction. The first condition is for when Pond E is fully disturbed and Pond D is still being pumped and treated prior to discharge. This condition, identified in the model as "Pond E E&S", is used to estimate flows to the Pond E conveyance channels prior to the establishment of vegetation. The second condition, identified in the model as "Pond DE E&S", is for after vegetation has become established in Pond E and the Pond D embankment is breached, allowing the full runoff from disturbed portions of the Pond D drainage area to enter the Pond E channels and Sediment basin.

During construction of Pond ABC, 3 drainage areas are modeled which drain directly to 2 sediment basins.

Post Construction Conditions

The Pond D-E system will discharge at a single location near the outlet of the temporary sediment basin. This model is the same as was developed for the "During Construction" models, except that the temporary sediment basin has been removed and the curve numbers represent that of vegetation for both ponds.

Pond ABC will have two separate discharges near the locations of the outlets of the temporary sediment basins. This model is the same as was developed for the "During Construction" model, except that the temporary sediment basins have been removed and the curve numbers represent that of vegetation.
Summary Output from the HEC-HMS Modeling is included as Attachment 7.

SUBJECT POSSUM POINT CCR POND CLOSURES
SITE HYDROLOGIC ANALYSES
BY SCHELAB DATE 06/28/2015 PROJ. NO. C150132.00
CHKD. BY BERKEME DATE 07/9/2015

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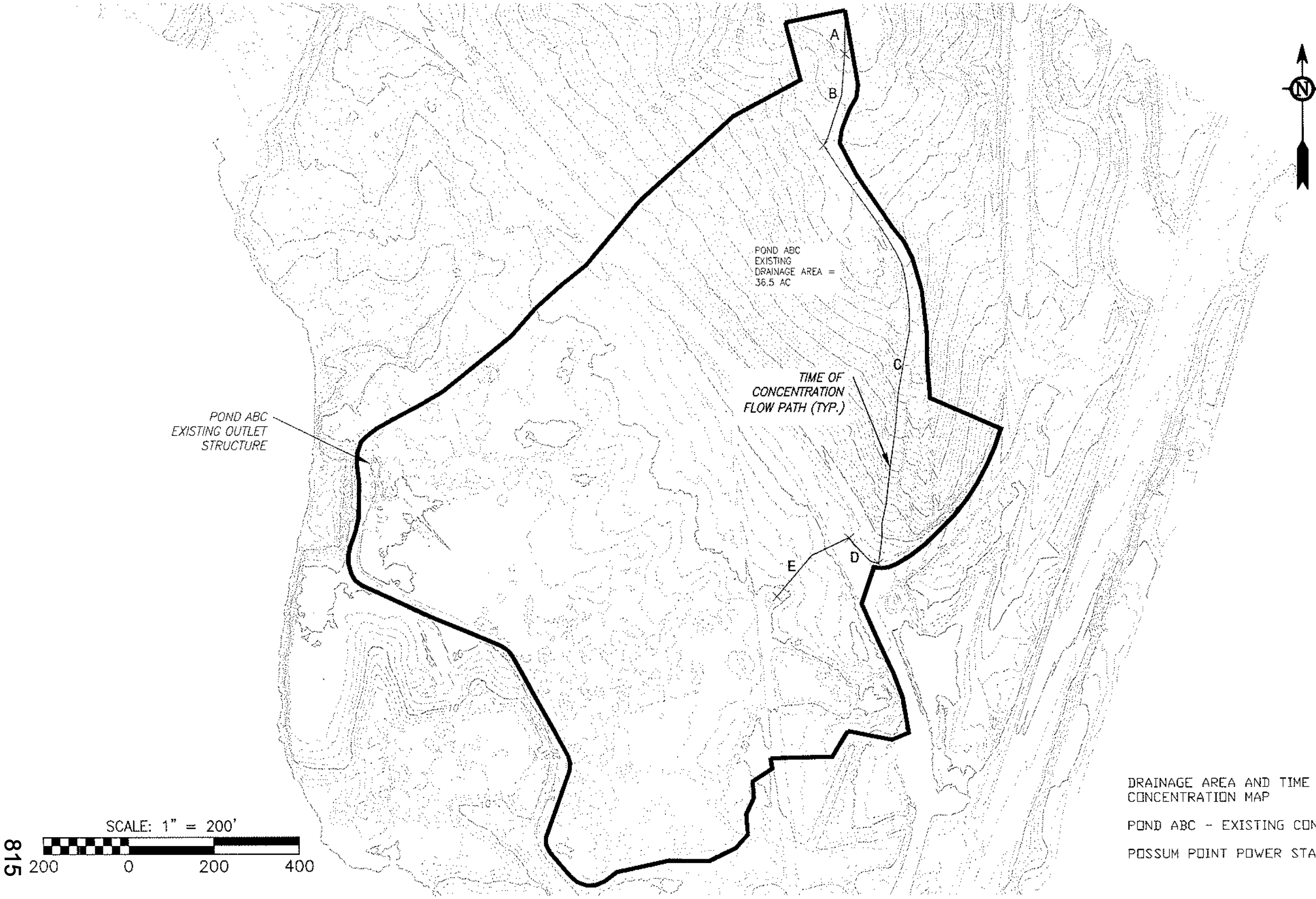
ATTACHMENT 1

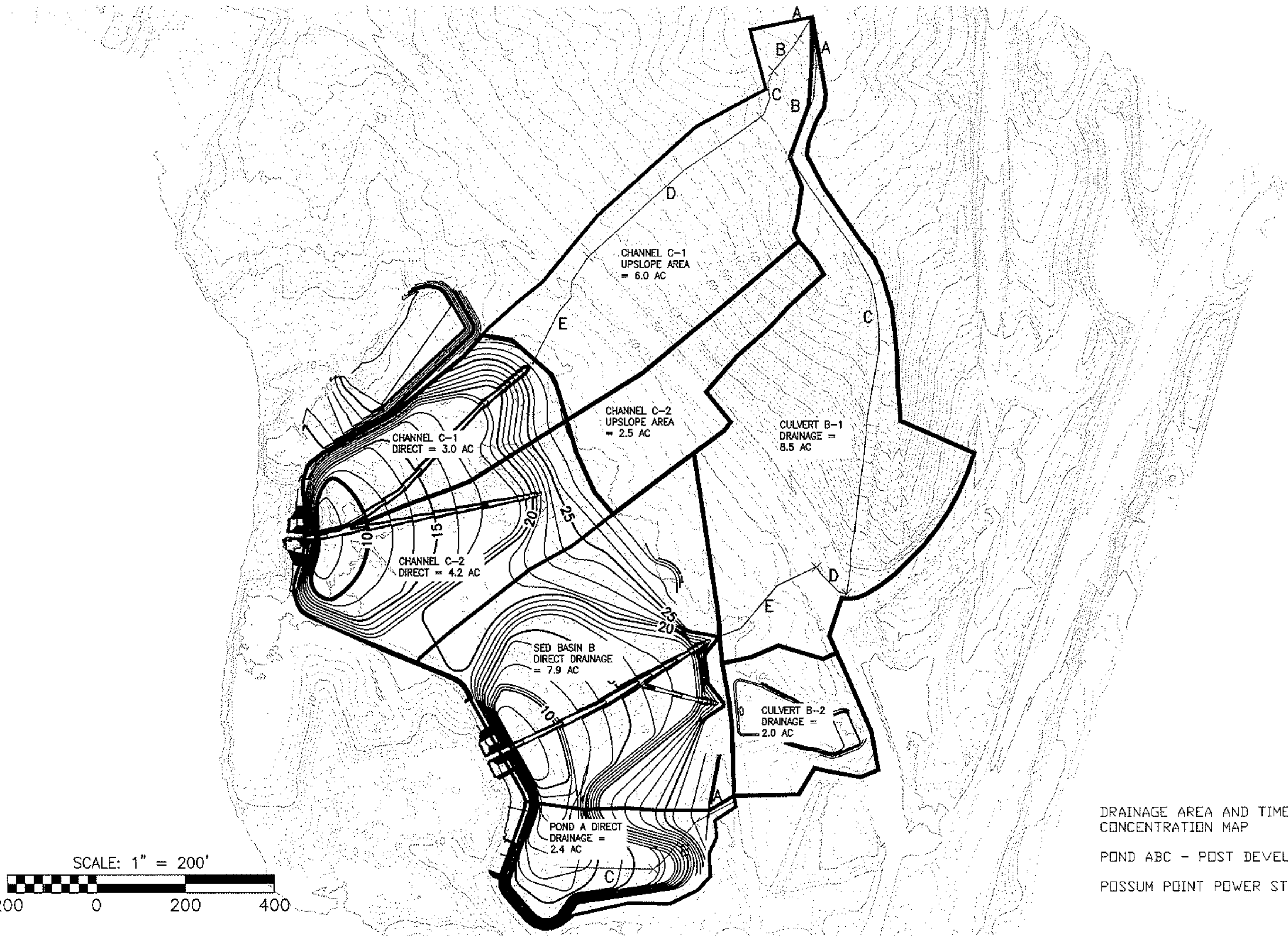
DRAINAGE AREA MAPS



DRAINAGE AREA AND TIME OF CONCENTRATION MAP

POND ABC - EXISTING CONDITIONS

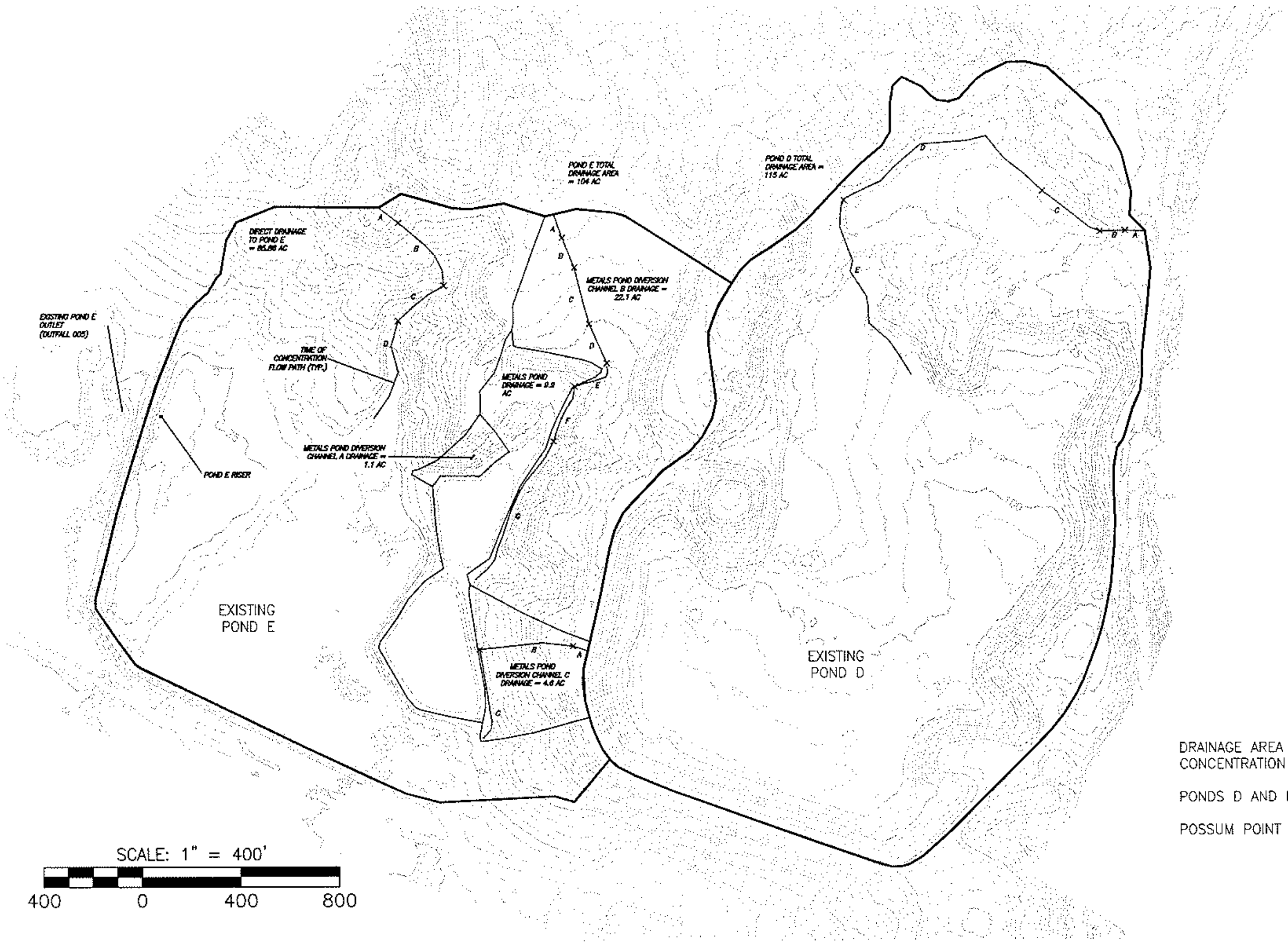
POSSUM POINT POWER STATION



DRAINAGE AREA AND TIME OF
CONCENTRATION MAP

POND ABC – POST DEVELOPMENT

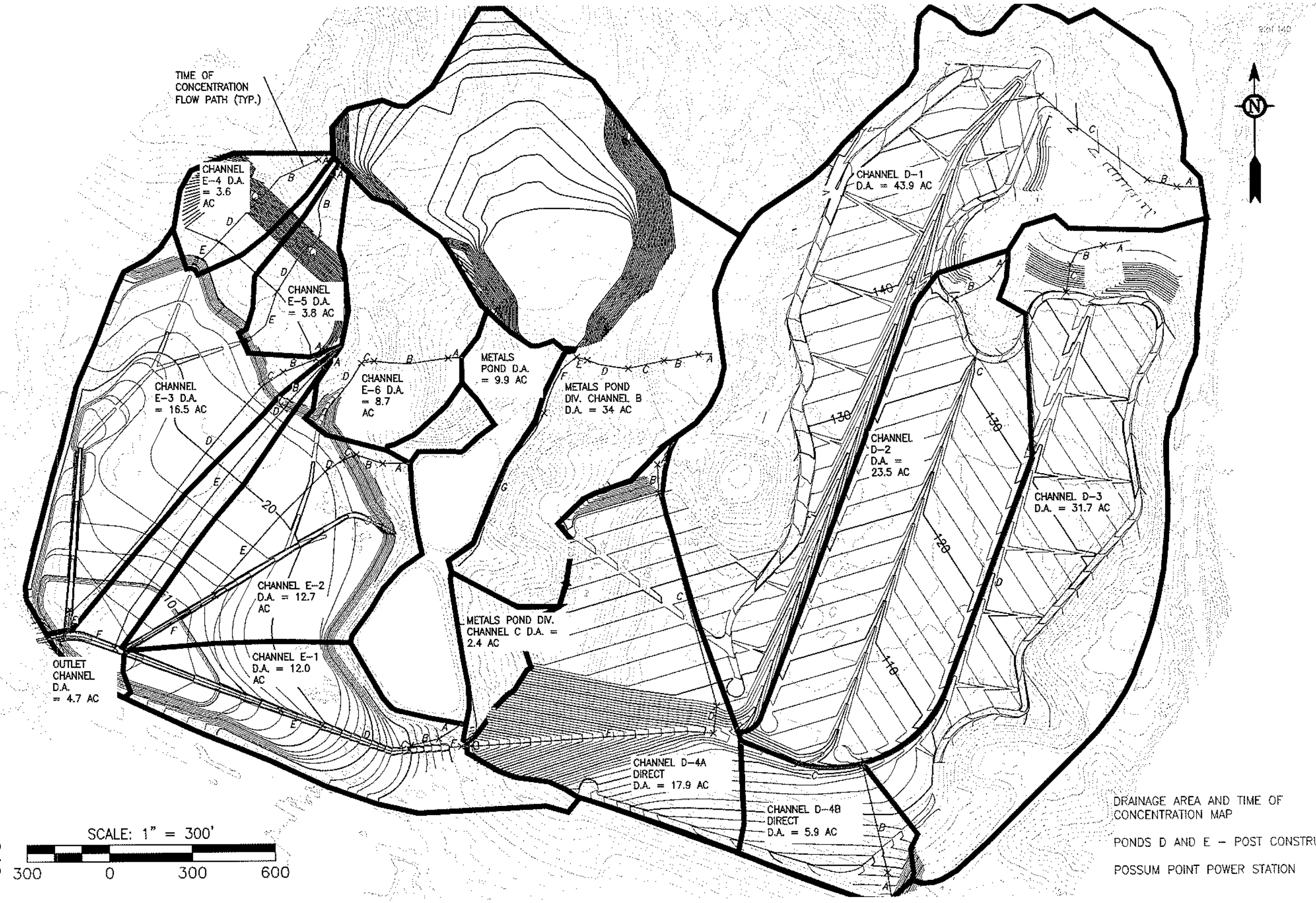
POSSUM POINT POWER STATION



DRAINAGE AREA AND TIME OF
CONCENTRATION MAP

PONDS D AND E – EXISTING CONDITIONS

POSSUM POINT POWER STATION



DRAINAGE AREA AND TIME OF CONCENTRATION MAP

PONDS D AND E – POST CONSTRUCTION

POSSUM POINT POWER STATION

ATTACHMENT 2

SOIL DATA

Hydrologic Soil Group—Prince William County, Virginia
(Possum Point Pond D and E)

Map Scale: 1:6,630 if printed on B landscape (17" x 11") sheet.

0 50 100 200 300 Meters

0 300 600 1200 1800 Feet

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Prince William County, Virginia
Survey Area Data: Version 12, Dec 13, 2013

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Apr 14, 2011—Nov 7, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Prince William County, Virginia (VA153)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
16A	Delanco fine sandy loam, 0 to 4 percent slopes	C/D	2.3	0.5%
18C	Dumfries sandy loam, 7 to 15 percent slopes	A	0.6	0.1%
18D	Dumfries sandy loam, 15 to 25 percent slopes	A	5.7	1.2%
18E	Dumfries sandy loam, 25 to 50 percent slopes	A	132.3	28.6%
22A	Featherstone mucky silt loam, 0 to 1 percent slopes	B/D	1.8	0.4%
27A	Hatboro-Codorus complex, 0 to 2 percent slopes	B/D	4.7	1.0%
34C	Lunt loam, 7 to 15 percent slopes	B	7.1	1.5%
34D	Lunt loam, 15 to 25 percent slopes	B	6.1	1.3%
36D	Marr very fine sandy loam, 7 to 25 percent slopes	B	42.1	9.1%
36E	Marr very fine sandy loam, 25 to 50 percent slopes	B	66.0	14.3%
37A	Marumsco loam, 0 to 4 percent slopes	C/D	23.7	5.1%
41C	Neabsco loam, 7 to 15 percent slopes	D	2.3	0.5%
42B	Neabsco-Quantico complex, 2 to 7 percent slopes	D	23.4	5.1%
47B	Quantico sandy loam, 2 to 7 percent slopes	B	20.9	4.5%
47C	Quantico sandy loam, 7 to 15 percent slopes	B	19.7	4.3%
47D	Quantico sandy loam, 15 to 25 percent slopes	B	3.7	0.8%
54B	Urban land-Udorthents complex, 0 to 7 percent slopes		4.2	0.9%
W	Water		95.8	20.7%
Totals for Area of Interest			**462.6**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: *None Specified*

Tie-break Rule: Higher

Hydrologic Soil Group—Charles County, Maryland, and Prince William County, Virginia
(Possum Point Pond ABC)

Map Scale: 1:7,260 if printed on A landscape (11" x 8.5") sheet.

Meters: 0 100 200 400 600

Feet: 0 350 700 1400 2100

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

824

15 of 140

MAP LEGEND

Area of Interest (AOI)
Area of Interest (AOI)

Soils

Soil Rating Polygons
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at scales ranging from 1:12,000 to 1:15,800.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Charles County, Maryland
Survey Area Data: Version 8, Sep 24, 2014

Soil Survey Area: Prince William County, Virginia
Survey Area Data: Version 12, Dec 13, 2013

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Apr 14, 2011—Nov 7, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

825

16 of 140

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Charles County, Maryland (MD017)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
W	Water		8.4	4.2%
Subtotals for Soil Survey Area			**8.4**	**4.2%**
Totals for Area of Interest			**200.6**	**100.0%**

Hydrologic Soil Group— Summary by Map Unit — Prince William County, Virginia (VA153)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
16A	Delanco fine sandy loam, 0 to 4 percent slopes	C/D	2.9	1.4%
18D	Dumfries sandy loam, 15 to 25 percent slopes	A	13.3	6.6%
18E	Dumfries sandy loam, 25 to 50 percent slopes	A	4.2	2.1%
22A	Featherstone mucky silt loam, 0 to 1 percent slopes	B/D	0.9	0.4%
27A	Hatboro-Codorus complex, 0 to 2 percent slopes	B/D	4.4	2.2%
36D	Marr very fine sandy loam, 7 to 25 percent slopes	B	3.4	1.7%
36E	Marr very fine sandy loam, 25 to 50 percent slopes	B	10.7	5.3%
37A	Marumsco loam, 0 to 4 percent slopes	C/D	8.4	4.2%
41B	Neabsco loam, 0 to 7 percent slopes	D	2.4	1.2%
42B	Neabsco-Quantico complex, 2 to 7 percent slopes	D	1.8	0.9%
47B	Quantico sandy loam, 2 to 7 percent slopes	B	26.7	13.3%
47C	Quantico sandy loam, 7 to 15 percent slopes	B	15.6	7.8%
47D	Quantico sandy loam, 15 to 25 percent slopes	B	3.0	1.5%
54B	Urban land-Udorthents complex, 0 to 7 percent slopes		69.8	34.8%
W	Water		24.8	12.4%

Hydrologic Soil Group— Summary by Map Unit — Prince William County, Virginia (VA153)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
Subtotals for Soil Survey Area			**192.2**	**95.8%**
Totals for Area of Interest			**200.6**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: *None Specified*

Tie-break Rule: Higher

ATTACHMENT 3

CURVE NUMBER AND TOC CALCULATIONS

Runoff Curve Number

Project: Possum Point Pond Closures - H&H Calculations C150132.00	By: SCHELAB	Date: 6/18/2015
Location: Pond ABC Direct Drainage Area	Checked: BERKEME	Date: 6/23/2015

Check one: ■ Present ❑ Under Development ❑ Developed

Hydrologic Group	Cover Description	CN Table 2-2*	CN Figure 2-3	CN Figure 2-4	Area ■ Acres ❑ miles² ❑ %	Product of CN x Area
A	Woods (fair)	36			6.0	217
B	Woods (fair)	60			8.8	531
D	Woods (fair)	79			1.3	104
D	Roads (gravel)	91			1.8	164
A	Meadow	30			2.3	69
B	Meadow	58			12.5	726
D	Meadow	78			3.7	288
			TOTALS		**36.5**	**2,099**

CN (weighted) = Total Product / Total Area

CN	**57**

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

Possum Point Pond Closures C150132.00	By: SCHELAB	Date: 6/23/2015
Location: Pond ABC, Existing Conditions	Checked: BERKEME	Date: 6/23/2015

Check one:	■ Present	☐ Under Development	☐ Developed

Sheet Flow

Segment ID	A	
Surface Description	Dense Grass	
Manning's Roughness Coefficient, n	0.24	(TR-55, Table 3-1)
Flow Length, L	100	ft
Two-year 24-hour Rainfall, P_2	3.12	in
Land Slope, s	0.05	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$	**0.1670**	**hrs**

Shallow Concentrated Flow

Segment ID	B		
Surface Description (Paved / Unpaved)	Unpaved		
Surface Description Coefficient, C	16.13		
Flow Length, L	213		ft
Watercourse Slope, s	0.113		ft/ft
Average Velocity, $V = C*s^{0.5}$	5.42		ft/sec
Travel Time, $T_t = (L) / (3600*V)$	**0.011**		**hrs**

Channel Flow

Segment ID	C	D	E	
Section Base, b	0	0	2	
Section Depth, d	1	1	2	
Section Side Slope, z	2	2	2	
Cross Sectional Flow Area, $a = b*d + z*d^2$	2	2	12	
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$	4.47	4.47	10.94	
Hydraulic Radius, $r = a / p_w$	0.45	0.45	1.10	
Channel Slope, s	0.102	0.011	0.070	
Manning's Roughness Coefficient, n	0.04	0.04	0.04	
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$	6.96	2.26	10.48	ft/sec
Flow Length, L	1039	93	280	ft
Travel Time, $T_t = (L) / (3600*V)$	**0.0415**	**0.0114**	**0.0074**	**hrs**

Time of Concentration

Sheet Flow T_t	0.1670	hrs
Shallow Concentrated Flow T_t	0.0109	hrs
Channel Flow Tt	0.0603	hrs
Time of Concentration, T_c	**0.2382**	**hrs**
	14	**mins**

Runoff Curve Number

Project:	By:	Date:
Possum Point Pond Closures - H&H Calculations	SCHELAB	8/23/2015
C150132.00	Checked:	Date:
Location:	PATTEJR	8/26/2015
Pond ABC, Channel C-2 Direct Drainage		

Check one:	☐ Present	☐ Under Development	■ Developed

Hydrologic Group	Cover Description	CN			Area	Product of CN x Area
		Table 2-2*	Figure 2-3	Figure 2-4	■ Acres ☐ miles^2 ☐ %	
A	Meadow	30			0.0	0
B	Meadow	58			0.0	0
A	Woods (fair)	36			0.0	0
B	Woods (fair)	60			0.0	0
D	Gravel	91			0.0	0
B	Revegetated Cover	58			4.2	244
			TOTALS		**4.2**	**244**

CN (weighted) = Total Product / Total Area

CN	**58**

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

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Runoff Curve Number

Project:	By:	Date:
Possum Point Pond Closures - H&H Calculations	SCHELAB	8/23/2015
C150132.00	Checked:	Date:
	PATTEJR	8/27/2015
Location:		
Pond ABC, Channel C-2 Upslope Drainage		

Check one: ❑ Present ❑ Under Development ■ Developed

Hydrologic Group	Cover Description	CN Table 2-2*	CN Figure 2-3	CN Figure 2-4	Area ■ Acres ❑ $miles^2$ ❑ %	Product of CN x Area
A	Meadow	30			0.0	1
B	Meadow	58			1.8	103
A	Woods (fair)	36			0.4	14
B	Woods (fair)	60			0.0	2
D	Gravel	91			0.3	27
B	Revegetated Cover	58			0.0	0
			TOTALS		**2.5**	**146**

CN (weighted) = Total Product / Total Area

CN	**58**

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

Runoff Curve Number

Project: Possum Point Pond Closures - H&H Calculations C150132.00	By: SCHELAB	Date: 8/23/2015
Location: Pond ABC, Channel C-1 Direct Drainage	Checked: PATTEJR	Date: 8/27/2015

Check one: ❑ Present ❑ Under Development ■ Developed

Hydrologic Group	Cover Description	CN Table 2-2*	CN Figure 2-3	CN Figure 2-4	Area ■ Acres ❑ miles^2 ❑ %	Product of CN x Area
A	Meadow	30			0.0	0
B	Meadow	58			0.0	0
A	Woods (fair)	36			0.0	0
B	Woods (fair)	60			0.0	0
D	Gravel	91			0.0	0
B	Revegetated Cover	58			3.0	171
			TOTALS		**3.0**	**171**

CN (weighted) = Total Product / Total Area

CN	**58**

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

Runoff Curve Number

Project: Possum Point Pond Closures - H&H Calculations C150132.00	By: SCHELAB	Date: 8/23/2015
Location: Pond ABC, Channel C-1 Upslope Drainage	Checked: PATTEJR	Date: 8/27/2015

Check one: ❑ Present ❑ Under Development ■ Developed

Hydrologic Group	Cover Description	CN			Area	Product of CN x Area
		Table 2-2*	Figure 2-3	Figure 2-4	■ Acres ❑ $miles^2$ ❑ %	
A	Meadow	30			0.6	19
B	Meadow	58			1.5	86
A	Woods (fair)	36			2.1	77
B	Woods (fair)	60			1.0	61
D	Gravel	91			0.7	63
B	Revegetated Cover	58			0.0	0
			TOTALS		**6.0**	**305**

CN (weighted) = Total Product / Total Area

CN	**51**

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

Runoff Curve Number

Project: Possum Point Pond Closures - H&H Calculations C150132.00	By: CUMMIRM	Date: 6/26/2015
	Checked: BERKEME	Date: 6/29/2015
Location: Pond ABC, Sediment Basin A		

Check one: ☐ Present ☐ Under Development ■ Developed

Hydrologic Group	Cover Description	CN			Area	Product of CN x Area
		Table 2-2*	Figure 2-3	Figure 2-4	■ Acres ☐ $miles^2$ ☐ %	
C	Meadow	71			0.03	2
B	Woods (fair)	60			0.1	8
C	Woods (fair)	73			0.04	3
B	Re-Vegetated Cap	58			2.2	126
			TOTALS		**2.4**	**139**

CN (weighted) = Total Product / Total Area

CN	**59**

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

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Runoff Curve Number

Project:		By:	Date:
Possum Point Pond Closures - H&H Calculations		SCHELAB	7/2/2015
C150132.00		Checked:	Date:
Location:		PATTEJR	8/7/2015
Pond ABC, Culvert B-1			

Check one: ❑ Present ❑ Under Development ■ Developed

Hydrologic Group	Cover Description	CN			Area	Product of CN x Area
		Table 2-2*	Figure 2-3	Figure 2-4	■ Acres ❑ miles² ❑ %	
A	Meadow	30			0.0	0
B	Meadow	58			3.8	219
A	Woods (fair)	36			3.0	108
B	Woods (fair)	60			0.8	50
D	Gravel	91			0.8	75
B	Re-Vegetated Cap	58			0.0	1
			TOTALS		**8.5**	**453**

CN (weighted) = Total Product / Total Area

CN	**54**

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

Runoff Curve Number

Project: Possum Point Pond Closures - H&H Calculations C150132.00	By: SCHELAB	Date: 7/2/2015
Location: Pond ABC, Culvert B-2	Checked: PATTEJR	Date: 8/7/2015

Check one: ❑ Present ❑ Under Development ■ Developed

Hydrologic Group	Cover Description	CN			Area	Product of CN x Area
		Table 2-2*	Figure 2-3	Figure 2-4	■ Acres ❑ $miles^2$ ❑ %	
A	Meadow	30			0.3	8
B	Meadow	58			0.8	47
B	Woods (fair)	60			0.2	12
B	Re-Vegetated Cap	58			0.7	43
			TOTALS		**2.0**	**110**

CN (weighted) = Total Product / Total Area

CN	**55**

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

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Runoff Curve Number

Project: Possum Point Pond Closures - H&H Calculations C150132.00	By: SCHELAB	Date: 7/2/2015
Location: Pond ABC, Sediment Basin B Direct Drainage	Checked: PATTEJR	Date: 8/7/2015

Check one:	❑ Present	❑ Under Development	■ Developed

Hydrologic Group	Cover Description	CN			Area	Product of CN x Area
		Table 2-2*	Figure 2-3	Figure 2-4	■ Acres ❑ miles^2 ❑ %	
B	Meadow	58			0.9	51
B	Woods (fair)	60			0.1	5
B	Re-Vegetated Cap	58			7.0	403
				TOTALS	**7.9**	**460**

CN (weighted) = Total Product / Total Area

CN	**58**

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

Possum Point Pond Closures C150132.00	By: BERKEME	Date: 6/26/2015
Location: Pond ABC, Pond A Direct Drainage	Checked: CUMMIRM	Date: 7/1/2015

Check one:	☐ Present	☐ Under Development	■ Developed

Sheet Flow

Segment ID	A		
Surface Description	Grass		
Manning's Roughness Coefficient, n	0.24		(TR-55, Table 3-1)
Flow Length, L	50	ft	
Two-year 24-hour Rainfall, P_2	3.12	in	
Land Slope, s	0.04	ft/ft	
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$	**0.1048**	**hrs**	

Shallow Concentrated Flow

Segment ID	B	C	
Surface Description (Paved / Unpaved)	Unpaved	Unpaved	
Surface Description Coefficient, C	16.13	16.13	
Flow Length, L	141	211	ft
Watercourse Slope, s	0.113	0.010	ft/ft
Average Velocity, $V = C*s^{0.5}$	5.44	1.61	ft/sec
Travel Time, $T_t = (L) / (3600*V)$	**0.007**	**0.036**	**hrs**

Channel Flow

Segment ID			
Section Base, b			
Section Depth, d			
Section Side Slope, z			
Cross Sectional Flow Area, $a = b*d + z*d^2$			
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$			
Hydraulic Radius, $r = a / p_w$			
Channel Slope, s			
Manning's Roughness Coefficient, n			
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$			ft/sec
Flow Length, L			ft
Travel Time, $T_t = (L) / (3600*V)$			**hrs**

Time of Concentration

Sheet Flow T_t	0.1048	hrs
Shallow Concentrated Flow T_t	0.0435	hrs
Channel Flow Tt	0.0000	hrs
Time of Concentration, T_c	**0.1484**	**hrs**
	9	**mins**

	By:	Date:
Possum Point Pond Closures C150132.00	BERKEME	6/26/2015
Location: Pond ABC, Culvert B-1	Checked: SCHELAB	Date: 7/2/2015

Check one: ☐ Present ☐ Under Development ■ Developed

Sheet Flow

Segment ID	A		
Surface Description	Grass		
Manning's Roughness Coefficient, n	0.24		(TR-55, Table 3-1)
Flow Length, L	100	ft	
Two-year 24-hour Rainfall, P_2	3.12	in	
Land Slope, s	0.05	ft/ft	
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$	**0.1670**	**hrs**	

Shallow Concentrated Flow

Segment ID	B	
Surface Description (Paved / Unpaved)	Unpaved	
Surface Description Coefficient, C	16.13	
Flow Length, L	213	ft
Watercourse Slope, s	0.113	ft/ft
Average Velocity, $V = C*s^{0.5}$	5.42	ft/sec
Travel Time, $T_t = (L) / (3600*V)$	**0.011**	**hrs**

Channel Flow

Segment ID	C	D	E	
Section Base, b	0	0	2	
Section Depth, d	1	1	2	
Section Side Slope, z	2	2	2	
Cross Sectional Flow Area, $a = b*d + z*d^2$	2	2	12	
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$	4.47	4.47	10.94	
Hydraulic Radius, $r = a / p_w$	0.45	0.45	1.10	
Channel Slope, s	0.102	0.011	0.070	
Manning's Roughness Coefficient, n	0.04	0.04	0.04	
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$	6.96	2.26	10.48	ft/sec
Flow Length, L	1039	93	270	ft
Travel Time, $T_t = (L) / (3600*V)$	**0.0415**	**0.0114**	**0.0072**	**hrs**

Time of Concentration

Sheet Flow T_t	0.1670	hrs
Shallow Concentrated Flow T_t	0.0109	hrs
Channel Flow Tt	0.0601	hrs
Time of Concentration, T_c	**0.2380**	**hrs**
	14	**mins**

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Possum Point Pond Closures C150132.00	By: BERKEME	Date: 7/2/2015
Location: Pond ABC, Channels C-1 and C-2	Checked: SCHELAB	Date: 7/2/2015

Check one: ❑ Present ❑ Under Development ■ Developed

Sheet Flow

Segment ID	A		
Surface Description..........	Grass		
Manning's Roughness Coefficient, n	0.24		(TR-55, Table 3-1)
Flow Length, L..........	52	ft	
Two-year 24-hour Rainfall, P_2..........	3.12	in	
Land Slope, s..........	0.04	ft/ft	
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$..........	**0.1082**	**hrs**	

Shallow Concentrated Flow

Segment ID	B	C	D	E	
Surface Description (Paved / Unpaved)..........	Unpaved	Unpaved	Unpaved	Unpaved	
Surface Description Coefficient, C..........	16.13	16.13	16.13	16.13	
Flow Length, L..........	90	109	498	423	ft
Watercourse Slope, s..........	0.211	0.046	0.205	0.071	ft/ft
Average Velocity, $V = C*s^{0.5}$..........	7.41	3.46	7.30	4.30	ft/sec
Travel Time, $T_t = (L) / (3600*V)$..........	**0.003**	**0.009**	**0.019**	**0.027**	**hrs**

Channel Flow

Segment ID			
Section Base, b..........			
Section Depth, d..........			
Section Side Slope, z..........			
Cross Sectional Flow Area, $a = b*d + z*d^2$...			
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$......			
Hydraulic Radius, $r = a / p_w$..........			
Channel Slope, s..........			
Manning's Roughness Coefficient, n......			
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$......			ft/sec
Flow Length, L..........			ft
Travel Time, $T_t = (L) / (3600*V)$..........			**hrs**

Time of Concentration

Sheet Flow T_t..........	0.1082	hrs
Shallow Concentrated Flow T_t..........	0.0584	hrs
Channel Flow Tt..........	0.0000	hrs
Time of Concentration, T_c..........	**0.1666**	**hrs**
	10	**mins**

Runoff Curve Number

Project: Possum Point Pond Closures - H&H Calculations C150132.00	By: SCHELAB	Date: 8/23/2015
Location: Pond ABC, Channel C-2 Direct Drainage	Checked: PATTEJR	Date: 8/27/2015

Check one: ❑ Present ■ Under Development ❑ Developed

Hydrologic Group	Cover Description	CN: Table 2-2*	CN: Figure 2-3	CN: Figure 2-4	Area ■ Acres ❑ miles^2 ❑ %	Product of CN x Area
A	Meadow	30			0.0	0
B	Meadow	58			0.0	0
A	Woods (fair)	36			0.0	0
B	Woods (fair)	60			0.0	0
D	Gravel	91			0.0	0
B	Bare Soil (dirt)	82			4.2	345
			TOTALS		**4.2**	**345**

CN (weighted) = Total Product / Total Area

CN	**82**

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

842

Runoff Curve Number

Project:	By:	Date:
Possum Point Pond Closures - H&H Calculations	SCHELAB	8/23/2015
C150132.00	Checked:	Date:
Location:	PATTEJR	8/27/2015
Pond ABC, Channel C-2 Upslope Drainage		

Check one: ❑ Present ■ Under Development ❑ Developed

Hydrologic Group	Cover Description	CN			Area	Product of CN x Area
		Table 2-2*	Figure 2-3	Figure 2-4	■ Acres ❑ $miles^2$ ❑ %	
A	Meadow	30			0.0	1
B	Meadow	58			1.8	103
A	Woods (fair)	36			0.4	14
B	Woods (fair)	60			0.0	2
D	Gravel	91			0.3	27
B	Bare Soil (dirt)	82			0.0	0
			TOTALS		**2.5**	**146**

CN (weighted) = Total Product / Total Area

CN	**58**

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

843

Runoff Curve Number

Project: Possum Point Pond Closures - H&H Calculations C150132.00	By: SCHELAB	Date: 8/23/2015
	Checked: PATTEJR	Date: 8/27/2015
Location: Pond ABC, Channel C-1 Direct Drainage		

Check one: ❑ Present ■ Under Development ❑ Developed

Hydrologic Group	Cover Description	CN			Area	Product of CN x Area
		Table 2-2*	Figure 2-3	Figure 2-4	■ Acres ❑ miles^2 ❑ %	
A	Meadow	30			0.0	0
B	Meadow	58			0.0	0
A	Woods (fair)	36			0.0	0
B	Woods (fair)	60			0.0	0
D	Gravel	91			0.0	0
B	Bare Soil (dirt)	82			3.0	242
			TOTALS		**3.0**	**242**

CN (weighted) = Total Product / Total Area

CN	**82**

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

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Runoff Curve Number

Project:	By:	Date:
Possum Point Pond Closures - H&H Calculations	SCHELAB	8/23/2015
C150132.00	Checked:	Date:
Location:	PATTEJR	8/27/2015
Pond ABC, Channel C-1 Upslope Drainage		

Check one: ❑ Present ■ Under Development ❑ Developed

Hydrologic Group	Cover Description	CN			Area	Product of CN x Area
		Table 2-2*	Figure 2-3	Figure 2-4	■ Acres ❑ $miles^2$ ❑ %	
A	Meadow	30			0.6	19
B	Meadow	58			1.5	86
A	Woods (fair)	36			2.1	77
B	Woods (fair)	60			1.0	61
D	Gravel	91			0.7	63
B	Bare Soil (dirt)	82			0.0	0
			TOTALS		**6.0**	**305**

CN (weighted) = Total Product / Total Area

CN	**51**

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

Runoff Curve Number

Project: Possum Point Pond Closures - H&H Calculations C150132.00	By: CUMMIRM	Date: 6/26/2015
Location: Pond ABC, Sediment Basin A	Checked: BERKEME	Date: 6/29/2015

Check one: ❑ Present ■ Under Development ❑ Developed

Hydrologic Group	Cover Description	CN: Table 2-2*	CN: Figure 2-3	CN: Figure 2-4	Area ■ Acres ❑ miles^2 ❑ %	Product of CN x Area
C	Meadow	71			0.03	2
B	Woods (fair)	60			0.1	8
C	Woods (fair)	73			0.04	3
B	Bare Soil (Dirt)	82			2.2	178
			TOTALS		**2.4**	**191**

CN (weighted) = Total Product / Total Area

CN	**81**

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

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Runoff Curve Number

Project:	By:	Date:
Possum Point Pond Closures - H&H Calculations	SCHELAB	7/2/2015
C150132.00	Checked:	Date:
Location:	PATTEJR	8/7/2015
Pond ABC, Culvert B-1		

Check one: ☐ Present ■ Under Development ☐ Developed

Hydrologic Group	Cover Description	CN: Table 2-2*	CN: Figure 2-3	CN: Figure 2-4	Area ■ Acres ☐ miles^2 ☐ %	Product of CN x Area
A	Meadow	30			0.0	0
B	Meadow	58			3.8	219
A	Woods (fair)	36			3.0	108
B	Woods (fair)	60			0.8	50
D	Gravel	91			0.8	75
B	Bare Soil (dirt)	82			0.0	1
			TOTALS		**8.5**	**453**

CN (weighted) = Total Product / Total Area

CN	**54**

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

847

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Runoff Curve Number

Project:	By:	Date:
Possum Point Pond Closures - H&H Calculations	SCHELAB	7/2/2015
C150132.00	Checked:	Date:
Location:	PATTEJR	8/7/2015
Pond ABC, Culvert B-2		

Check one: ❑ Present ■ Under Development ❑ Developed

Hydrologic Group	Cover Description	CN			Area	Product of CN x Area
		Table 2-2*	Figure 2-3	Figure 2-4	■ Acres ❑ $miles^2$ ❑ %	
A	Meadow	30			0.3	8
B	Meadow	58			0.8	47
B	Woods (fair)	60			0.2	12
B	Bare Soil (dirt)	82			0.7	61
			TOTALS		**2.0**	**128**

CN (weighted) = Total Product / Total Area

CN	**63**

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

Runoff Curve Number

Project:	By:	Date:
Possum Point Pond Closures - H&H Calculations	SCHELAB	7/2/2015
C150132.00	Checked:	Date:
Location:	PATTEJR	8/7/2015
Pond ABC, Sediment Basin B Direct Drainage		

Check one: ❑ Present ■ Under Development ❑ Developed

Hydrologic Group	Cover Description	CN			Area	Product of CN x Area
		Table 2-2*	Figure 2-3	Figure 2-4	■ Acres ❑ $miles^2$ ❑ %	
B	Meadow	58			0.9	51
B	Woods (fair)	60			0.1	5
B	Bare Soil (dirt)	82			7.0	570
			TOTALS		**7.9**	**626**

CN (weighted) = Total Product / Total Area

CN	**79**

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

Runoff Curve Number

Project: Possum Point Pond Closures - H&H Calculations C150132.00	By: SCHELAB	Date: 6/18/2015
Location: Pond D Direct Drainage Area	Checked: BERKEME	Date: 6/22/2015

Check one: ■ Present ❑ Under Development ❑ Developed

Hydrologic Group	Cover Description	CN			Area	Product of CN x Area
		Table 2-2*	Figure 2-3	Figure 2-4	■ Acres ❑ miles^2 ❑ %	
A	Meadow	30			25.4	762
B	Meadow	58			26.9	1,558
D	Meadow	78			3.7	287
A	Woods (Fair)	36			3.0	109
B	Woods (Fair)	60			6.6	394
D	Woods (Fair)	79			2.7	213
D	Gravel	91			3.3	297
			TOTALS		**71.5**	**3,619**

CN (weighted) = Total Product / Total Area

CN	**51**

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

Project: TOC Calculations Possum Point Power Station CCB Pond Closure	By: MBB	Date: 6/17/2015
Location: Pond D Existing Drainage Area	Checked: SCHELAB	Date: 6/22/2015

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Check one:	■ Present	❑ Under Development	❑ Developed

Sheet Flow

Segment ID	A	
Surface Description (Table 3-1)	Woods	
Manning's Roughness Coefficient, n (table 3-1)	0.4	
Flow Length, L	81	ft
Two-year 24-hour Rainfall, P_2	3.12	in
Land Slope, s	0.05	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$	**0.2123**	**hrs**

Shallow Concentrated Flow

Segment ID	B	C	
Surface Description (Paved / Unpaved)	Unpaved	Unpaved	
Surface Description Coefficient, C	16.1345	16.1345	
Flow Length, L	101	282	ft
Watercourse Slope, s	0.26	0.04	ft/ft
Average Velocity, $V = C*s^{0.5}$	8.19	3.33	ft/sec
Travel Time, $T_t = (L) / (3600*V)$	**0.0034**	**0.0235**	**hrs**

Channel Flow

Segment ID	D	E	
Section Base, b	1	2	
Section Depth, d	1.5	2	
Section Side Slope, z	1	1	
Cross Sectional Flow Area, $a = b*d + z*d^2$	3.75	8	
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$	5.24	7.66	
Hydraulic Radius, $r = a / p_w$	0.72	1.04	
Channel Slope, s	0.01	0.04	
Manning's Roughness Coefficient, n	0.035	0.035	
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$	4.07	9.04	ft/sec
Flow Length, L	978	800	ft
Travel Time, $T_t = (L) / (3600*V)$	**0.0667**	**0.0246**	**hrs**

Time of Concentration

Sheet Flow T_t	0.2123	hrs
Shallow Concentrated Flow T_t	0.0270	hrs
Channel Flow T_t	0.0913	hrs
Time of Concentration, T_c	**0.3305**	**hrs**
	20	**mins**

Runoff Curve Number

Project: C150132.00 Possum Point Power Station CCB Pond Closure	By: BERKEME	Date: 8/3/2015
	Checked: SCHELAB	Date: 8/11/2015
Location: Pond D, Channel D-1		

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Cover Description	CN			Post-Development	
	Table 2-2*	Figure 2-3	Figure 2-4	Area ■ Acres ☐ miles^2 ☐ %	Product of CN x Area
Meadow (A)	30			6.70	201.00
Meadow (B)	58			6.18	358.38
Meadow (D)	78			0.00	0.00
Woods (Fair) (A)	36			0.00	0.00
Woods (Fair) (B)	60			3.13	187.57
Woods (Fair) (D)	79			2.43	192.06
Revegetated Cap (B)	58			23.92	1,387.61
Impervious (D) (Gravel)	91			1.54	140.09
		TOTALS		**43.9**	2466.71

CN (WEIGHTED)	**56**

CN (Weighted) = Total Product/Total Area

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

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Runoff Curve Number

Project: C150132.00 Possum Point Power Station CCB Pond Closure	By: BERKEME	Date: 8/3/2015
Location: Pond D, Channel D-2	Checked: SCHELAB	Date: 8/11/2015

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Cover Description	CN: Table 2-2*	CN: Figure 2-3	CN: Figure 2-4	Post-Development Area ■ Acres ❑ miles² ❑ %	Product of CN x Area
Meadow (A)	30			0.00	0.00
Meadow (B)	58			1.15	66.51
Meadow (D)	78			0.00	0.00
Woods (Fair) (A)	36			0.00	0.00
Woods (Fair) (B)	60			0.00	0.00
Woods (Fair) (D)	79			0.00	0.00
Revegetated Cap (B)	58			22.35	1,296.49
Impervious (D) (Gravel)	91			0.00	0.00
		TOTALS		**23.5**	1363.00

CN (WEIGHTED)	**58**

CN (Weighted) = Total Product/Total Area
*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

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Runoff Curve Number

Project: C150132.00 Possum Point Power Station CCB Pond Closure	By: BERKEME	Date: 8/3/2015
	Checked: SCHELAB	Date: 8/11/2015
Location: Pond D, Channel D-3		

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Cover Description	CN			Post-Development	
	Table 2-2*	Figure 2-3	Figure 2-4	Area ■ Acres ☐ miles^2 ☐ %	Product of CN x Area
Meadow (A)	30			2.23	66.81
Meadow (B)	58			7.07	409.98
Meadow (D)	78			3.68	287.32
Woods (Fair) (A)	36			0.92	33.07
Woods (Fair) (B)	60			0.00	0.00
Woods (Fair) (D)	79			0.19	14.67
Revegetated Cap (B)	58			17.09	991.03
Impervious (D) (Gravel)	91			0.53	48.21
		TOTALS		31.7	1851.08

CN (WEIGHTED)	58

CN (Weighted) = Total Product/Total Area
*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

Runoff Curve Number

Project: C150132.00 Possum Point Power Station CCB Pond Closure	By: BERKEME	Date: 8/3/2015
	Checked: SCHELAB	Date: 8/11/2015
Location: Pond D, Channel D-4B		

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Cover Description	CN Table 2-2*	CN Figure 2-3	CN Figure 2-4	Post-Development Area ■ Acres ☐ $miles^2$ ☐ %	Product of CN x Area
Meadow (A)	30			0.00	0.00
Meadow (B)	58			0.00	0.00
Meadow (D)	78			0.00	0.00
Woods (Fair) (A)	36			0.00	0.00
Woods (Fair) (B)	60			0.00	0.00
Woods (Fair) (D)	79			0.00	0.00
Revegetated Cap (B)	58			5.90	342.20
Impervious (D) (Gravel)	91			0.00	0.00
		TOTALS		5.9	342.20

CN (WEIGHTED)	58

CN (Weighted) = Total Product/Total Area

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

Runoff Curve Number

Project: C150132.00 Possum Point Power Station CCB Pond Closure	By: BERKEME	Date: 8/3/2015	gai consultants
	Checked: SCHELAB	Date: 8/11/2015	
Location: Pond D, Channel D-4A			

Cover Description	CN			Post-Development	
	Table 2-2*	Figure 2-3	Figure 2-4	Area ■ Acres ❑ miles² ❑ %	Product of CN x Area
Meadow (A)	30			0.00	0.00
Meadow (B)	58			0.19	10.99
Meadow (D)	78			0.00	0.00
Woods (Fair) (A)	36			0.00	0.00
Woods (Fair) (B)	60			0.00	0.00
Woods (Fair) (D)	79			0.00	0.00
Revegetated Cap (B)	58			17.7	1,027.18
Impervious (D) (Gravel)	91			0.03	2.77
		TOTALS		**17.9**	1040.95

CN (WEIGHTED)	**58**

CN (Weighted) = Total Product/Total Area
*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

Project: TOC Calculations Possum Point Power Station CCB Pond Closure	By: BERKEME	Date: 8/3/2015
	Checked: SCHELAB	Date: 8/12/2015
Location: Pond D, Channel D-1		

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Check one:	❑ Present	■ Developed

Sheet Flow

	Segment ID	A	
Surface Description (Table 3-1)		Woods	
Manning's Roughness Coefficient, n (table 3-1)		0.4	
Flow Length, L		90	ft
Two-year 24-hour Rainfall, P_2		3.12	in
Land Slope, s		0.03	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$		**0.2833**	**hrs**

Shallow Concentrated Flow

	Segment ID	B	C	
Surface Description (Paved / Unpaved)		Unpaved	Unpaved	
Surface Description Coefficient, C		16.1345	16.1345	
Flow Length, L		112	494	ft
Watercourse Slope, s		0.16	0.07	ft/ft
Average Velocity, $V = C*s^{0.5}$		6.45	4.42	ft/sec
Travel Time, $T_t = (L) / (3600*V)$		**0.0048**	**0.0311**	**hrs**

Channel Flow

	Segment ID	E	
Section Base, b		10	
Section Depth, d		1.5	
Section Side Slope, z		5	
Cross Sectional Flow Area, $a = b*d + z*d^2$		26.25	
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$		25.30	
Hydraulic Radius, $r = a / p_w$		1.04	
Channel Slope, s		0.02	
Manning's Roughness Coefficient, n		0.035	
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$		6.17	ft/sec
Flow Length, L		2645	ft
Travel Time, $T_t = (L) / (3600*V)$		**0.1191**	**hrs**

Time of Concentration

Sheet Flow T_t	0.2833	hrs
Shallow Concentrated Flow T_t	0.0359	hrs
Channel Flow T_t	0.1191	hrs
Time of Concentration, T_c	**0.4382**	**hrs**
	26	**mins**

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Project: TOC Calculations Possum Point Power Station CCB Pond Closure	By: BERKEME	Date: 8/3/2015
	Checked: SCHELAB	Date: 8/12/2015
Location: Pond D, Channel D-2		

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Check one:	❑ Present	■ Developed

Sheet Flow

Segment ID	A	
Surface Description (Table 3-1)	Woods	
Manning's Roughness Coefficient, n (table 3-1)	0.4	
Flow Length, L	100	ft
Two-year 24-hour Rainfall, P_2	3.12	in
Land Slope, s	0.05	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$	**0.2512**	**hrs**

Shallow Concentrated Flow

Segment ID	B	
Surface Description (Paved / Unpaved)	Unpaved	
Surface Description Coefficient, C	16.1345	
Flow Length, L	153	ft
Watercourse Slope, s	0.20	ft/ft
Average Velocity, $V = C*s^{0.5}$	7.14	ft/sec
Travel Time, $T_t = (L) / (3600*V)$	**0.0059**	**hrs**

Channel Flow

Segment ID	C	
Section Base, b	10	
Section Depth, d	1.5	
Section Side Slope, z	5	
Cross Sectional Flow Area, $a = b*d + z*d^2$	26.25	
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$	25.30	
Hydraulic Radius, $r = a / p_w$	1.04	
Channel Slope, s	0.02	
Manning's Roughness Coefficient, n	0.035	
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$	5.34	ft/sec
Flow Length, L	1890	ft
Travel Time, $T_t = (L) / (3600*V)$	**0.0982**	**hrs**

Time of Concentration

Sheet Flow T_t	0.2512	hrs
Shallow Concentrated Flow T_t	0.0059	hrs
Channel Flow T_t	0.0982	hrs
Time of Concentration, T_c	**0.3554**	**hrs**
	21	**mins**

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Project: TOC Calculations Possum Point Power Station CCB Pond Closure	By: BERKEME	Date: 8/3/2015
	Checked: SCHELAB	Date: 8/12/2015
Location: Pond D, Channel D-3		

Check one: ☐ Present ■ Developed

Sheet Flow

Segment ID	A	
Surface Description (Table 3-1)	Grass	
Manning's Roughness Coefficient, n (table 3-1)	0.24	
Flow Length, L	100	ft
Two-year 24-hour Rainfall, P_2	3.12	in
Land Slope, s	0.04	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$	**0.1825**	**hrs**

Shallow Concentrated Flow

Segment ID	B	C	
Surface Description (Paved / Unpaved)	Unpaved	Unpaved	
Surface Description Coefficient, C	16.1345	16.1345	
Flow Length, L	148	102	ft
Watercourse Slope, s	0.07	0.25	ft/ft
Average Velocity, $V = C*s^{0.5}$	4.40	8.15	ft/sec
Travel Time, $T_t = (L) / (3600*V)$	**0.0093**	**0.0035**	**hrs**

Channel Flow

Segment ID	D	
Section Base, b	10	
Section Depth, d	1.5	
Section Side Slope, z	5	
Cross Sectional Flow Area, $a = b*d + z*d^2$	26.25	
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$	25.30	
Hydraulic Radius, $r = a / p_w$	1.04	
Channel Slope, s	0.02	
Manning's Roughness Coefficient, n	0.035	
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$	6.32	ft/sec
Flow Length, L	2046	ft
Travel Time, $T_t = (L) / (3600*V)$	**0.0899**	**hrs**

Time of Concentration

Sheet Flow T_t	0.1825	hrs
Shallow Concentrated Flow T_t	0.0128	hrs
Channel Flow T_t	0.0899	hrs
Time of Concentration, T_c	**0.2852**	**hrs**
	17	**mins**

Project: TOC Calculations Possum Point Power Station CCB Pond Closure	By: BERKEME	Date: 8/3/2015
	Checked: SCHELAB	Date: 8/12/2015
Location: Pond D, Channel D-4A		

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Check one:	☐ Present	■ Developed

Sheet Flow

Segment ID	A	
Surface Description (Table 3-1)	Grass	
Manning's Roughness Coefficient, n (table 3-1)	0.24	
Flow Length, L	100	ft
Two-year 24-hour Rainfall, P_2	3.12	in
Land Slope, s	0.04	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$	**0.1825**	**hrs**

Shallow Concentrated Flow

Segment ID	B	C	D	
Surface Description (Paved / Unpaved)	Unpaved	Unpaved	Unpaved	
Surface Description Coefficient, C	16.1345	16.1345	16.1345	
Flow Length, L	106	800	101	ft
Watercourse Slope, s	0.24	0.03	0.16	ft/ft
Average Velocity, $V = C*s^{0.5}$	7.84	2.55	6.42	ft/sec
Travel Time, $T_t = (L) / (3600*V)$	**0.0038**	**0.0871**	**0.0044**	**hrs**

Channel Flow

Segment ID	E	
Section Base, b	25	
Section Depth, d	4	
Section Side Slope, z	5	
Cross Sectional Flow Area, $a = b*d + z*d^2$	180	
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$	65.79	
Hydraulic Radius, $r = a / p_w$	2.74	
Channel Slope, s	0.04	
Manning's Roughness Coefficient, n	0.035	
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$	16.66	ft/sec
Flow Length, L	901	ft
Travel Time, $T_t = (L) / (3600*V)$	**0.0150**	**hrs**

Time of Concentration

Sheet Flow T_t	0.1825	hrs
Shallow Concentrated Flow T_t	0.0909	hrs
Channel Flow T_t	0.0150	hrs
Time of Concentration, T_c	**0.2884**	**hrs**
	17	**mins**

Project: TOC Calculations Possum Point Power Station CCB Pond Closure	By: BERKEME	Date: 8/3/2015
	Checked: SCHELAB	Date: 8/12/2015
Location: Pond D, Channel D-4B		

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Check one:	❑ Present	■ Developed

Sheet Flow

	Segment ID	
	A	
Surface Description (Table 3-1)	Grass	
Manning's Roughness Coefficient, n (table 3-1)	0.24	
Flow Length, L	100	ft
Two-year 24-hour Rainfall, P_2	3.12	in
Land Slope, s	0.05	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$	**0.1670**	**hrs**

Shallow Concentrated Flow

	Segment ID	
	B	
Surface Description (Paved / Unpaved)	Unpaved	
Surface Description Coefficient, C	16.1345	
Flow Length, L	404	ft
Watercourse Slope, s	0.05	ft/ft
Average Velocity, $V = C*s^{0.5}$	3.61	ft/sec
Travel Time, $T_t = (L) / (3600*V)$	**0.0311**	**hrs**

Channel Flow

	Segment ID	
	C	
Section Base, b	26	
Section Depth, d	4	
Section Side Slope, z	5	
Cross Sectional Flow Area, $a = b*d + z*d^2$	184	
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$	66.79	
Hydraulic Radius, $r = a / p_w$	2.75	
Channel Slope, s	0.015	
Manning's Roughness Coefficient, n	0.035	
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$	10.25	ft/sec
Flow Length, L	461	ft
Travel Time, $T_t = (L) / (3600*V)$	**0.0125**	**hrs**

Time of Concentration

Sheet Flow T_t	0.1670	hrs
Shallow Concentrated Flow T_t	0.0311	hrs
Channel Flow T_t	0.0125	hrs
Time of Concentration, T_c	**0.2106**	**hrs**
	13	**mins**

Runoff Curve Number

Project: C150132.00 Possum Point Power Station CCB Pond Closure	By: BERKEME	Date: 8/3/2015	gai consultants
Location: Pond D, Channel D-1	Checked: SCHELAB	Date: 8/11/2015	

Cover Description	CN			During Construction	
	Table 2-2*	Figure 2-3	Figure 2-4	Area ■ Acres ❑ miles^2 ❑ %	Product of CN x Area
Meadow (A)	30			6.70	201.00
Meadow (B)	58			6.18	358.38
Meadow (D)	78			0.00	0.00
Woods (Fair) (A)	36			0.00	0.00
Woods (Fair) (B)	60			3.13	187.57
Woods (Fair) (D)	79			2.43	192.06
Bare Soil (B)	82			23.92	1,961.79
Impervious (D) (Gravel)	91			1.54	140.09
		TOTALS		**43.9**	3040.89

CN (WEIGHTED)	**69**

CN (Weighted) = Total Product/Total Area

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

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Runoff Curve Number

Project: C150132.00 Possum Point Power Station CCB Pond Closure	By: BERKEME	Date: 8/3/2015
	Checked: SCHELAB	Date: 8/11/2015
Location: Pond D, Channel D-2		

gai consultants

Cover Description	CN: Table 2-2*	CN: Figure 2-3	CN: Figure 2-4	During Construction: Area ■ Acres ❑ miles² ❑ %	During Construction: Product of CN x Area
Meadow (A)	30			0.00	0.00
Meadow (B)	58			1.15	66.51
Meadow (D)	78			0.00	0.00
Woods (Fair) (A)	36			0.00	0.00
Woods (Fair) (B)	60			0.00	0.00
Woods (Fair) (D)	79			0.00	0.00
Bare Soil (B)	82			22.35	1,832.97
Impervious (D) (Gravel)	91			0.00	0.00
		TOTALS		**23.5**	1899.48

CN (WEIGHTED)	**81**

CN (Weighted) = Total Product/Total Area
*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

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Runoff Curve Number

Project: C150132.00 Possum Point Power Station CCB Pond Closure	By: BERKEME	Date: 8/3/2015
Location: Pond D, Channel D-3	Checked: SCHELAB	Date: 8/11/2015

gai consultants

Cover Description	CN: Table 2-2*	CN: Figure 2-3	CN: Figure 2-4	During Construction: Area ■ Acres ❑ miles² ❑ %	During Construction: Product of CN x Area
Meadow (A)	30			2.23	66.81
Meadow (B)	58			7.07	409.98
Meadow (D)	78			3.68	287.32
Woods (Fair) (A)	36			0.92	33.07
Woods (Fair) (B)	60			0.00	0.00
Woods (Fair) (D)	79			0.19	14.67
Bare Soil (B)	82			17.09	1,401.11
Impervious (D) (Gravel)	91			0.53	48.21
		TOTALS		**31.7**	2261.16

CN (WEIGHTED)	**71**

CN (Weighted) = Total Product/Total Area
*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

Runoff Curve Number

Project: C150132.00 Possum Point Power Station CCB Pond Closure	By: BERKEME	Date: 8/3/2015
	Checked: SCHELAB	Date: 8/11/2015
Location: Pond D, Channel D-4B		

gai consultants

Cover Description	CN Table 2-2*	CN Figure 2-3	CN Figure 2-4	During Construction Area ■ Acres ❑ miles^2 ❑ %	Product of CN x Area
Meadow (A)	30			0.00	0.00
Meadow (B)	58			0.00	0.00
Meadow (D)	78			0.00	0.00
Woods (Fair) (A)	36			0.00	0.00
Woods (Fair) (B)	60			0.00	0.00
Woods (Fair) (D)	79			0.00	0.00
Bare Soil (B)	82			5.90	483.80
Impervious (D) (Gravel)	91			0.00	0.00
		TOTALS		**5.9**	483.80

CN (WEIGHTED)	**82**

CN (Weighted) = Total Product/Total Area

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

Runoff Curve Number

Project:	By:	Date:
C150132.00	BERKEME	8/3/2015
Possum Point Power Station CCB Pond Closure	Checked:	Date:
Location:	SCHELAB	8/11/2015
Pond D, Channel D-4A		

gai consultants

Cover Description	CN			During Construction	
	Table 2-2*	Figure 2-3	Figure 2-4	Area ■ Acres ❑ miles² ❑ %	Product of CN x Area
Meadow (A)	30			0.00	0.00
Meadow (B)	58			0.19	10.99
Meadow (D)	78			0.00	0.00
Woods (Fair) (A)	36			0.00	0.00
Woods (Fair) (B)	60			0.00	0.00
Woods (Fair) (D)	79			0.00	0.00
Bare Soil (B)	82			17.7	1,452.22
Impervious (D) (Gravel)	91			0.03	2.77
		TOTALS		**17.9**	1465.99

CN (WEIGHTED)	**82**

CN (Weighted) = Total Product/Total Area
*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

Runoff Curve Number

Project: Possum Point Pond Closures - H&H Calculations C150132.00	By: SCHELAB	Date: 6/18/2015
	Checked: BERKEME	Date: 6/22/2015
Location: Pond E Direct Drainage Area		

Check one: ■ Present ❑ Under Development ❑ Developed

Hydrologic Group	Cover Description	CN			Area	Product of CN x Area
		Table 2-2*	Figure 2-3	Figure 2-4	■ Acres ❑ miles² ❑ %	
A	Woods (fair)	36			4.0	144
B	Woods (fair)	60			6.7	400
A	Meadow	30			9.1	272
B	Meadow	58			12.8	741
D	Meadow	78			4.5	347
			TOTALS		**37.0**	**1,905**

CN (weighted) = Total Product / Total Area

CN	**52**

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

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Runoff Curve Number

Project: Possum Point Pond Closures - H&H Calculations C150132.00	By: SCHELAB	Date: 4/28/2015
Location: Pond E Metals Diversion A	Checked: BERKEME	Date: 6/22/2015

Check one: ■ Present ❑ Under Development ❑ Developed

Hydrologic Group	Cover Description	CN: Table 2-2*	CN: Figure 2-3	CN: Figure 2-4	Area ■ Acres ❑ miles^2 ❑ %	Product of CN x Area
A	Woods (fair)	60			1.0	62
A	Meadow	78			0.04	3
			TOTALS		**1.1**	**65**

CN (weighted) = Total Product / Total Area

CN	**61**

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

Runoff Curve Number

Project:	By:	Date:
Possum Point Pond Closures - H&H Calculations	SCHELAB	5/28/2015
C150132.00	Checked:	Date:
Location:	BERKEME	6/22/2015
Pond E Metals Diversion B		

Check one: ■ Present ❑ Under Development ❑ Developed

Hydrologic Group	Cover Description	CN			Area	Product of CN x Area
		Table 2-2*	Figure 2-3	Figure 2-4	■ Acres ❑ $miles^2$ ❑ %	
A	Woods (fair)	36			5.1	182
B	Woods (fair)	60			0.9	55
A	Meadow	30			6.1	182
B	Meadow	58			10.1	583
			TOTALS		**22.1**	**1,002**

CN (weighted) = Total Product / Total Area

CN	**45**

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

Runoff Curve Number

Project: Possum Point Pond Closures - H&H Calculations C150132.00	By: SCHELAB	Date: 6/18/2015
Location: Pond E Metals Diversion C	Checked: BERKEME	Date: 6/22/2015

Check one: ■ Present ☐ Under Development ☐ Developed

Hydrologic Group	Cover Description	CN: Table 2-2*	CN: Figure 2-3	CN: Figure 2-4	Area ■ Acres ☐ miles^2 ☐ %	Product of CN x Area
B	Woods (fair)	60			2.9	176
B	Meadow	58			1.7	99
			TOTALS		**4.7**	**276**

CN (weighted) = Total Product / Total Area

CN	**59**

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

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Possum Point Pond Closures C150132.00	By: SCHELAB	Date: 6/18/2015
Location: Pond E Direct Drainage Area	Checked: BERKEME	Date: 6/22/2015

Check one: ■ Present ☐ Under Development ☐ Developed

Sheet Flow

Segment ID	A	
Surface Description	Woods	
Manning's Roughness Coefficient, n	0.4	(TR-55, Table 3-1)
Flow Length, L	100	ft
Two-year 24-hour Rainfall, P_2	3.12	in
Land Slope, s	0.19	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$	**0.1473**	**hrs**

Shallow Concentrated Flow

Segment ID	B		
Surface Description (Paved / Unpaved)	Unpaved		
Surface Description Coefficient, C	16.13		
Flow Length, L	325		ft
Watercourse Slope, s	0.178		ft/ft
Average Velocity, $V = C*s^{0.5}$	6.82		ft/sec
Travel Time, $T_t = (L) / (3600*V)$	**0.013**		**hrs**

Channel Flow

Segment ID	C	D	
Section Base, b	2	4	
Section Depth, d	1.5	1.5	
Section Side Slope, z	2	2	
Cross Sectional Flow Area, $a = b*d + z*d^2$	7.5	10.5	
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$	8.71	10.71	
Hydraulic Radius, $r = a / p_w$	0.86	0.98	
Channel Slope, s	0.111	0.037	
Manning's Roughness Coefficient, n	0.045	0.045	
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$	9.99	6.29	ft/sec
Flow Length, L	235	428	ft
Travel Time, $T_t = (L) / (3600*V)$	**0.0065**	**0.0189**	**hrs**

Time of Concentration

Sheet Flow T_t	0.1473	hrs
Shallow Concentrated Flow T_t	0.0132	hrs
Channel Flow Tt	0.0254	hrs
Time of Concentration, T_c	**0.1860**	**hrs**
	11	**mins**

Possum Point Pond Closures C150132.00	By: SCHELAB	Date: 6/23/2015
Location: Pond E Metals Diversion B	Checked: BERKEME	Date: 6/23/2015

Check one: ■ Present ☐ Under Development ☐ Developed

Sheet Flow

Segment ID	A		
Surface Description	Dense Grass		
Manning's Roughness Coefficient, n	0.24		(TR-55, Table 3-1)
Flow Length, L	100	ft	
Two-year 24-hour Rainfall, P_2	3.12	in	
Land Slope, s	0.04	ft/ft	
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$	**0.1904**	**hrs**	

Shallow Concentrated Flow

Segment ID	B	C	D		
Surface Description (Paved / Unpaved)	Unpaved	Unpaved	Unpaved		
Surface Description Coefficient, C	16.13	16.13	16.13		
Flow Length, L	130	232	175		ft
Watercourse Slope, s	0.042	0.065	0.034		ft/ft
Average Velocity, $V = C*s^{0.5}$	3.31	4.11	2.98		ft/sec
Travel Time, $T_t = (L) / (3600*V)$	**0.011**	**0.016**	**0.016**		**hrs**

Channel Flow

Segment ID	E	F	G	
Section Base, b	0	0	0	
Section Depth, d	1	1.5	2	
Section Side Slope, z	2	2	2	
Cross Sectional Flow Area, $a = b*d + z*d^2$	2	4.5	8	
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$	4.47	6.71	8.94	
Hydraulic Radius, $r = a / p_w$	0.45	0.67	0.89	
Channel Slope, s	0.300	0.078	0.018	
Manning's Roughness Coefficient, n	0.045	0.045	0.045	
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$	10.61	7.09	4.12	ft/sec
Flow Length, L	118	652	652	ft
Travel Time, $T_t = (L) / (3600*V)$	**0.0031**	**0.0256**	**0.0439**	**hrs**

Time of Concentration

Sheet Flow T_t	0.1904	hrs
Shallow Concentrated Flow T_t	0.0429	hrs
Channel Flow Tt	0.0726	hrs
Time of Concentration, T_c	**0.3059**	**hrs**
	18	**mins**

Possum Point Pond Closures C150132.00	By: SCHELAB	Date: 4/28/2015
Location: Pond E Metals Diversion C	Checked: BERKEME	Date: 6/22/2015

Check one:	■ Present	❑ Under Development	❑ Developed

Sheet Flow

Segment ID	A		
Surface Description	Dense Grass		
Manning's Roughness Coefficient, n	0.24		(TR-55, Table 3-1)
Flow Length, L	55	ft	
Two-year 24-hour Rainfall, P_2	3.12	in	
Land Slope, s	0.04	ft/ft	
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$	**0.1132**	**hrs**	

Shallow Concentrated Flow

Segment ID	B				
Surface Description (Paved / Unpaved)	Unpaved				
Surface Description Coefficient, C	16.13				
Flow Length, L	381				ft
Watercourse Slope, s	0.218				ft/ft
Average Velocity, $V = C*s^{0.5}$	7.53				ft/sec
Travel Time, $T_t = (L) / (3600*V)$	**0.014**				**hrs**

Channel Flow

Segment ID	C		
Section Base, b	0		
Section Depth, d	1.5		
Section Side Slope, z	2		
Cross Sectional Flow Area, $a = b*d + z*d^2$	4.5		
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$	6.71		
Hydraulic Radius, $r = a / p_w$	0.67		
Channel Slope, s	0.032		
Manning's Roughness Coefficient, n	0.045		
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$	4.54		ft/sec
Flow Length, L	374		ft
Travel Time, $T_t = (L) / (3600*V)$	**0.0229**		**hrs**

Time of Concentration

Sheet Flow T_t	0.1132	hrs
Shallow Concentrated Flow T_t	0.0140	hrs
Channel Flow Tt	0.0229	hrs
Time of Concentration, T_c	**0.1501**	**hrs**
	9	**mins**

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Runoff Curve Number

Project: Possum Point Pond Closures - H&H Calculations C150132.00	By: SCHELAB	Date: 6/22/2015
Location: Pond E, Metals Diversion B	Checked: BERKEME	Date: 6/23/2015

Check one: ❑ Present ❑ Under Development ■ Developed

Hydrologic Group	Cover Description	CN Table 2-2*	CN Figure 2-3	CN Figure 2-4	Area ■ Acres ❑ miles^2 ❑ %	Product of CN x Area
A	Woods (fair)	36			4.4	159
B	Woods (fair)	60			0.6	39
B	Revegetated	58			20.7	1,202
A	Meadow	30			2.9	88
B	Meadow	58			5.1	295
			TOTALS		**33.8**	**1,783**

CN (weighted) = Total Product / Total Area

CN	**53**

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

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Runoff Curve Number

Project: Possum Point Pond Closures - H&H Calculations C150132.00	By: SCHELAB	Date: 6/22/2015
Location: Pond E, Metals Diversion C	Checked: BERKEME	Date: 6/22/2015

Check one: ❑ Present ❑ Under Development ■ Developed

Hydrologic Group	Cover Description	CN			Area	Product of CN x Area
		Table 2-2*	Figure 2-3	Figure 2-4	■ Acres ❑ miles^2 ❑ %	
A	Woods (fair)	36			0.06	2.3
B	Woods (fair)	60			1.6	95
B	Meadow	58			0.8	45
			TOTALS		2.4	143

CN (weighted) = Total Product / Total Area

CN	59

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

875

Runoff Curve Number

Project: Possum Point Pond Closures - H&H Calculations C150132.00	By: BRENDCF	Date: 8/20/2015
Location: Pond E, Chanel E-1 Direct Runoff	Checked: BREKEME	Date: 8/20/2015

Check one: ❑ Present ❑ Under Development ■ Developed

Hydrologic Group	Cover Description	CN			Area	Product of CN x Area
		Table 2-2*	Figure 2-3	Figure 2-4	■ Acres ❑ $miles^2$ ❑ %	
B	Revegetated	58			8.7	504
B	Meadow	58			2.2	130
C	Gravel	91			1.0	95
			TOTALS		**12.0**	**730**

CN (weighted) = Total Product / Total Area

CN	**61**

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

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Runoff Curve Number

Project:	By:	Date:
Possum Point Pond Closures - H&H Calculations	BRENDCF	8/20/2015
C150132.00	Checked:	Date:
Location:	BREKEME	8/20/2015
Pond E, Channel E-2 Direct Runoff		

Check one: ❑ Present ❑ Under Development ■ Developed

Hydrologic Group	Cover Description	CN			Area	Product of CN x Area
		Table 2-2*	Figure 2-3	Figure 2-4	■ Acres ❑ miles^2 ❑ %	
B	Revegetated	58			11.3	653
A	Meadow	30			0.9	27
B	Meadow	58			0.5	29
			TOTALS		12.7	710

CN (weighted) = Total Product / Total Area

CN	56

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

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Runoff Curve Number

Project:	By:	Date:
Possum Point Pond Closures - H&H Calculations	BRENDCF	8/20/2015
C150132.00	Checked:	Date:
Location:	BREKEME	8/20/2015
Pond E, Channel E-3 Direct Runoff		

Check one: ❑ Present ❑ Under Development ■ Developed

Hydrologic Group	Cover Description	CN			Area	Product of CN x Area
		Table 2-2*	Figure 2-3	Figure 2-4	■ Acres ❑ miles^2 ❑ %	
B	Revegetated	58			14.9	866
A	Meadow	30			0.2	5
B	Meadow	58			0.5	28
B	Woods (fair)	60			0.05	3
C	Gravel	91			0.9	82
			TOTALS		**16.5**	**983**

CN (weighted) = Total Product / Total Area

CN	**60**

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

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Runoff Curve Number

Project:	By:	Date:
Possum Point Pond Closures - H&H Calculations	BRENDCF	8/20/2015
C150132.00	Checked:	Date:
Location:	BREKEME	8/20/2015
Pond E, Outlet Channel Direct Runoff		

Check one: ☐ Present ☐ Under Development ■ Developed

Hydrologic Group	Cover Description	CN			Area	Product of CN x Area
		Table 2-2*	Figure 2-3	Figure 2-4	■ Acres ☐ $miles^2$ ☐ %	
B	Revegetated	58			4.3	249
A	Meadow	30			0.05	1.4
B	Meadow	58			0.1	5.9
B	Woods (fair)	60			0.05	3.0
C	Gravel	91			0.2	18
			TOTALS		**4.7**	**278**

CN (weighted) = Total Product / Total Area

CN	**59**

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

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Runoff Curve Number

Project: Possum Point Pond Closures - H&H Calculations C150132.00	By: BERKEME	Date: 7/30/2015
Location: Pond E, Channel E-4	Checked: SCHELAB	Date: 8/11/2015

Check one: ❑ Present ❑ Under Development ■ Developed

Hydrologic Group	Cover Description	CN			Area	Product of CN x Area
		Table 2-2*	Figure 2-3	Figure 2-4	■ Acres ❑ $miles^2$ ❑ %	
N/A	Riprap Area	91			0.1	9
A	Meadow	30			0.5	14
B	Meadow	58			0.9	51
B	Revegetated Area	58			2.2	125
			TOTALS		**3.6**	**199**

CN (weighted) = Total Product / Total Area

CN	**55**

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

Runoff Curve Number

Project:	By:	Date:
Possum Point Pond Closures - H&H Calculations	BERKEME	7/30/2015
C150132.00	Checked:	Date:
Location:	SCHELAB	8/11/2015
Pond E, Channel E-5		

Check one: ☐ Present ☐ Under Development ■ Developed

Hydrologic Group	Cover Description	CN			Area	Product of CN x Area
		Table 2-2*	Figure 2-3	Figure 2-4	■ Acres ☐ miles^2 ☐ %	
N/A	Riprap Area	89			0.1	5
A	Meadow	30			0.3	9
B	Meadow	58			0.7	39
B	Woods	60			0.4	27
B	Revegetated Area	58			2.3	134
			TOTALS		**3.8**	**215**

CN (weighted) = Total Product / Total Area

CN	**56**

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

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Runoff Curve Number

Project: Possum Point Pond Closures - H&H Calculations C150132.00	By: BERKEME	Date: 7/30/2015
Location: Pond E, Channel E-6	Checked: SCHELAB	Date: 8/11/2015

Check one: ❑ Present ❑ Under Development ■ Developed

Hydrologic Group	Cover Description	CN			Area	Product of CN x Area
		Table 2-2*	Figure 2-3	Figure 2-4	■ Acres ❑ $miles^2$ ❑ %	
N/A	Riprap Area	89			0.2	16
A	Meadow	30			2.3	69
B	Meadow	58			2.6	153
B	Woods	60			3.6	218
			TOTALS		**8.7**	**455**

CN (weighted) = Total Product / Total Area

CN	**52**

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

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Possum Point Pond Closures C150132.00	By: SCHELAB	Date: 8/20/2015
Location: Pond E, Channel E1 Direct Drainage Area	Checked: BERKEME	Date: 8/21/2015

Check one: ❑ Present ❑ Under Development ■ Developed

Sheet Flow

Segment ID	A		
Surface Description	Dense Grass		
Manning's Roughness Coefficient, n	0.24		(TR-55, Table 3-1)
Flow Length, L	100	ft	
Two-year 24-hour Rainfall, P_2	3.12	in	
Land Slope, s	0.13	ft/ft	
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$	**0.1139**	**hrs**	

Shallow Concentrated Flow

Segment ID	B	
Surface Description (Paved / Unpaved)	Unpaved	
Surface Description Coefficient, C	16.13	
Flow Length, L	105	ft
Watercourse Slope, s	0.076	ft/ft
Average Velocity, $V = C*s^{0.5}$	4.45	ft/sec
Travel Time, $T_t = (L) / (3600*V)$	**0.0066**	**hrs**

Channel Flow

Segment ID	C	D	E	
Section Base, b	15	15	15	
Section Depth, d	4	4	4	
Section Side Slope, z	2	2	2	
Cross Sectional Flow Area, $a = b*d + z*d^2$	92	92	92	
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$	32.89	32.89	32.89	
Hydraulic Radius, $r = a / p_w$	2.80	2.80	2.80	
Channel Slope, s	0.060	0.020	0.010	
Manning's Roughness Coefficient, n	0.041	0.041	0.041	
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$	17.67	10.20	7.21	ft/sec
Flow Length, L	335	165	601	ft
Travel Time, $T_t = (L) / (3600*V)$	**0.0053**	**0.0045**	**0.0231**	**hrs**

Time of Concentration

Sheet Flow T_t	0.1139	hrs
Shallow Concentrated Flow T_t	0.0066	hrs
Channel Flow Tt	0.0329	hrs
Time of Concentration, T_c	**0.1534**	**hrs**
	9	**mins**

Possum Point Pond Closures C150132.00	By: SCHELAB	Date: 8/20/2015
Location: Pond E, Channel E2 Direct Drainage Area	Checked: BERKEME	Date: 8/21/2015

Check one: ☐ Present ☐ Under Development ■ Developed

Sheet Flow

Segment ID	A		
Surface Description	Woods		
Manning's Roughness Coefficient, n	0.4		(TR-55, Table 3-1)
Flow Length, L	100	ft	
Two-year 24-hour Rainfall, P_2	3.12	in	
Land Slope, s	0.10	ft/ft	
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$	**0.1919**	**hrs**	

Shallow Concentrated Flow

Segment ID	B	C	D	E	
Surface Description (Paved / Unpaved)	Unpaved	Unpaved	Unpaved	Unpaved	
Surface Description Coefficient, C	16.13	16.13	16.13	16.13	
Flow Length, L	100	55	76	615	ft
Watercourse Slope, s	0.120	0.330	0.050	0.012	ft/ft
Average Velocity, $V = C*s^{0.5}$	5.59	9.27	3.61	1.77	ft/sec
Travel Time, $T_t = (L) / (3600*V)$	**0.0050**	**0.0016**	**0.0059**	**0.0967**	**hrs**

Channel Flow

Segment ID	F	
Section Base, b	10	
Section Depth, d	2	
Section Side Slope, z	2	
Cross Sectional Flow Area, $a = b*d + z*d^2$	28	
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$	18.94	
Hydraulic Radius, $r = a / p_w$	1.48	
Channel Slope, s	0.010	
Manning's Roughness Coefficient, n	0.041	
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$	4.72	ft/sec
Flow Length, L	383	ft
Travel Time, $T_t = (L) / (3600*V)$	**0.0226**	**hrs**

Time of Concentration

Sheet Flow T_t	0.1919	hrs
Shallow Concentrated Flow T_t	0.1091	hrs
Channel Flow Tt	0.0226	hrs
Time of Concentration, T_c	**0.3236**	**hrs**
	19	**mins**

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Possum Point Pond Closures C150132.00	By: SCHELAB	Date: 8/21/2015
Location: Pond E, Channel E3 Direct Drainage Area	Checked: BERKEME	Date: 8/21/2015

Check one: ☐ Present ☐ Under Development ■ Developed

Sheet Flow

Segment ID	A		
Surface Description	Woods		
Manning's Roughness Coefficient, n	0.4		(TR-55, Table 3-1)
Flow Length, L	100	ft	
Two-year 24-hour Rainfall, P_2	3.12	in	
Land Slope, s	0.07	ft/ft	
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$	**0.2196**	**hrs**	

Shallow Concentrated Flow

Segment ID	B	C	D	
Surface Description (Paved / Unpaved)	Unpaved	Unpaved	Unpaved	
Surface Description Coefficient, C	16.13	16.13	16.13	
Flow Length, L	131	96	1070	ft
Watercourse Slope, s	0.070	0.210	0.012	ft/ft
Average Velocity, $V = C*s^{0.5}$	4.27	7.39	1.77	ft/sec
Travel Time, $T_t = (L) / (3600*V)$	**0.0085**	**0.0036**	**0.1682**	**hrs**

Channel Flow

Segment ID	C	
Section Base, b	10	
Section Depth, d	2	
Section Side Slope, z	2	
Cross Sectional Flow Area, $a = b*d + z*d^2$	28	
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$	18.94	
Hydraulic Radius, $r = a / p_w$	1.48	
Channel Slope, s	0.010	
Manning's Roughness Coefficient, n	0.041	
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$	4.72	ft/sec
Flow Length, L	76	ft
Travel Time, $T_t = (L) / (3600*V)$	**0.0045**	**hrs**

Time of Concentration

Sheet Flow T_t	0.2196	hrs
Shallow Concentrated Flow T_t	0.1803	hrs
Channel Flow Tt	0.0045	hrs
Time of Concentration, T_c	**0.4044**	**hrs**
	24	**mins**

Possum Point Pond Closures C150132.00	By: SCHELAB	Date: 8/21/2015
Location: Pond E, Outlet Channel Direct Drainage	Checked: BERKEME	Date: 8/21/2015

Check one: ☐ Present ☐ Under Development ■ Developed

Sheet Flow

Segment ID	A		
Surface Description	Woods		
Manning's Roughness Coefficient, n	0.4		(TR-55, Table 3-1)
Flow Length, L	100	ft	
Two-year 24-hour Rainfall, P_2	3.12	in	
Land Slope, s	0.06	ft/ft	
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$	**0.2368**	**hrs**	

Shallow Concentrated Flow

Segment ID	B	C	D	E	
Surface Description (Paved / Unpaved)	Unpaved	Unpaved	Unpaved	Unpaved	
Surface Description Coefficient, C	16.13	16.13	16.13	16.13	
Flow Length, L	172	37	74	903	ft
Watercourse Slope, s	0.090	0.333	0.020	0.012	ft/ft
Average Velocity, $V = C*s^{0.5}$	4.84	9.31	2.28	1.77	ft/sec
Travel Time, $T_t = (L) / (3600*V)$	**0.0099**	**0.0011**	**0.0090**	**0.1419**	**hrs**

Channel Flow

Segment ID	F	
Section Base, b	15	
Section Depth, d	4	
Section Side Slope, z	2	
Cross Sectional Flow Area, $a = b*d + z*d^2$	92	
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$	32.89	
Hydraulic Radius, $r = a / p_w$	2.80	
Channel Slope, s	0.010	
Manning's Roughness Coefficient, n	0.041	
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$	7.21	ft/sec
Flow Length, L	247	ft
Travel Time, $T_t = (L) / (3600*V)$	**0.0095**	**hrs**

Time of Concentration

Sheet Flow T_t	0.2368	hrs
Shallow Concentrated Flow T_t	0.1619	hrs
Channel Flow Tt	0.0095	hrs
Time of Concentration, T_c	**0.4082**	**hrs**
	24	**mins**

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Possum Point Pond Closures C150132.00	By: SCHELAB	Date: 6/22/2015
Location: Pond E Metals Diversion C	Checked: BERKEME	Date: 6/23/2015

Check one: ❑ Present ❑ Under Development ■ Developed

Sheet Flow

Segment ID			
Surface Description	Dense Grass		
Manning's Roughness Coefficient, n	0.24		(TR-55, Table 3-1)
Flow Length, L	0	ft	
Two-year 24-hour Rainfall, P_2	3.12	in	
Land Slope, s	0.06	ft/ft	
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$	**0.0000**	**hrs**	

Shallow Concentrated Flow

Segment ID	A		
Surface Description (Paved / Unpaved)	Unpaved		
Surface Description Coefficient, C	16.13		
Flow Length, L	294		ft
Watercourse Slope, s	0.224		ft/ft
Average Velocity, $V = C*s^{0.5}$	7.64		ft/sec
Travel Time, $T_t = (L) / (3600*V)$	**0.011**		**hrs**

Channel Flow

Segment ID	B		
Section Base, b	0		
Section Depth, d	1.5		
Section Side Slope, z	2		
Cross Sectional Flow Area, $a = b*d + z*d^2$	4.5		
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$	6.71		
Hydraulic Radius, $r = a / p_w$	0.67		
Channel Slope, s	0.029		
Manning's Roughness Coefficient, n	0.045		
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$	4.32		ft/sec
Flow Length, L	448		ft
Travel Time, $T_t = (L) / (3600*V)$	**0.0288**		**hrs**

Time of Concentration

Sheet Flow T_t	0.0000	hrs
Shallow Concentrated Flow T_t	0.0107	hrs
Channel Flow Tt	0.0288	hrs
Time of Concentration, T_c	**0.0395**	**hrs**
	2	**mins**

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Possum Point Pond Closures C150132.00	By: BERKEME	Date: 7/30/2015
Location: Pond E, Channel E-4	Checked: SCHELAB	Date: 8/12/2015

Check one: ❑ Present ❑ Under Development ■ Developed

Sheet Flow

Segment ID	A	
Surface Description	Dense Grass	
Manning's Roughness Coefficient, n	0.24	(TR-55, Table 3-1)
Flow Length, L	32	ft
Two-year 24-hour Rainfall, P_2	3.12	in
Land Slope, s	0.25	ft/ft
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$	**0.0352**	**hrs**

Shallow Concentrated Flow

Segment ID	B	C	D	E	
Surface Description (Paved / Unpaved)	Unpaved	Unpaved	Unpaved	Unpaved	
Surface Description Coefficient, C	16.13	16.13	16.13	16.13	
Flow Length, L	217	108	151	85	ft
Watercourse Slope, s	0.286	0.333	0.005	0.120	ft/ft
Average Velocity, $V = C*s^{0.5}$	8.62	9.32	1.14	5.59	ft/sec
Travel Time, $T_t = (L) / (3600*V)$	**0.007**	**0.003**	**0.037**	**0.004**	**hrs**

Channel Flow

Segment ID		
Section Base, b		
Section Depth, d		
Section Side Slope, z		
Cross Sectional Flow Area, $a = b*d + z*d^2$		
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$		
Hydraulic Radius, $r = a / p_w$		
Channel Slope, s		
Manning's Roughness Coefficient, n		
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$		ft/sec
Flow Length, L		ft
Travel Time, $T_t = (L) / (3600*V)$		**hrs**

Time of Concentration

Sheet Flow T_t	0.0352	hrs
Shallow Concentrated Flow T_t	0.0512	hrs
Channel Flow Tt	0.0000	hrs
Time of Concentration, T_c	**0.0864**	**hrs**
	5	**mins**

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Possum Point Pond Closures C150132.00	By: BERKEME	Date: 7/30/2015
Location: Pond E, Channel E-5	Checked: SCHELAB	Date: 8/12/2015

Check one: ☐ Present ☐ Under Development ■ Developed

Sheet Flow

Segment ID	A		
Surface Description	Dense Grass		
Manning's Roughness Coefficient, n	0.24		(TR-55, Table 3-1)
Flow Length, L	50	ft	
Two-year 24-hour Rainfall, P_2	3.12	in	
Land Slope, s	0.32	ft/ft	
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$	**0.0456**	**hrs**	

Shallow Concentrated Flow

Segment ID	B	C	D	E	
Surface Description (Paved / Unpaved)	Unpaved	Unpaved	Unpaved	Unpaved	
Surface Description Coefficient, C	16.13	16.13	16.13	16.13	
Flow Length, L	240	103	145	196	ft
Watercourse Slope, s	0.250	0.330	0.005	0.080	ft/ft
Average Velocity, $V = C*s^{0.5}$	8.07	9.27	1.14	4.56	ft/sec
Travel Time, $T_t = (L) / (3600*V)$	**0.008**	**0.003**	**0.035**	**0.012**	**hrs**

Channel Flow

Segment ID		
Section Base, b		
Section Depth, d		
Section Side Slope, z		
Cross Sectional Flow Area, $a = b*d + z*d^2$		
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$		
Hydraulic Radius, $r = a / p_w$		
Channel Slope, s		
Manning's Roughness Coefficient, n		
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$		ft/sec
Flow Length, L		ft
Travel Time, $T_t = (L) / (3600*V)$		**hrs**

Time of Concentration

Sheet Flow T_t	0.0456	hrs
Shallow Concentrated Flow T_t	0.0586	hrs
Channel Flow Tt	0.0000	hrs
Time of Concentration, T_c	**0.1042**	**hrs**
	6	**mins**

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Possum Point Pond Closures C150132.00	By: BERKEME	Date: 7/30/2015
Location: Pond E, Channel E-6	Checked: SCHELAB	Date: 8/12/2015

Check one: ☐ Present ☐ Under Development ■ Developed

Sheet Flow

Segment ID	A		
Surface Description	Dense Grass		
Manning's Roughness Coefficient, n	0.24		(TR-55, Table 3-1)
Flow Length, L	50	ft	
Two-year 24-hour Rainfall, P_2	3.12	in	
Land Slope, s	0.03	ft/ft	
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$	**0.1146**	**hrs**	

Shallow Concentrated Flow

Segment ID	B	C	
Surface Description (Paved / Unpaved)	Unpaved	Unpaved	
Surface Description Coefficient, C	16.13	16.13	
Flow Length, L	273	47	ft
Watercourse Slope, s	0.283	0.040	ft/ft
Average Velocity, $V = C*s^{0.5}$	8.58	3.23	ft/sec
Travel Time, $T_t = (L) / (3600*V)$	**0.009**	**0.004**	**hrs**

Channel Flow

Segment ID	D			
Section Base, b	4			
Section Depth, d	1.5			
Section Side Slope, z	2			
Cross Sectional Flow Area, $a = b*d + z*d^2$	10.5			
Wetted Perimeter, $p_w = b + (2*d)*(z^2 + 1)^{0.5}$	10.71			
Hydraulic Radius, $r = a / p_w$	0.98			
Channel Slope, s	0.017			
Manning's Roughness Coefficient, n	0.045			
Average Velocity, $V = (1.49*r^{2/3}*s^{1/2}) / (n)$	4.26			ft/sec
Flow Length, L	239			ft
Travel Time, $T_t = (L) / (3600*V)$	**0.0156**			**hrs**

Time of Concentration

Sheet Flow T_t	0.1146	hrs
Shallow Concentrated Flow T_t	0.0129	hrs
Channel Flow Tt	0.0156	hrs
Time of Concentration, T_c	**0.1431**	**hrs**
	9	**mins**

Runoff Curve Number

Project: Possum Point Pond Closures - H&H Calculations C150132.00	By: BRENDCF	Date: 8/20/2015
Location: Pond E, Channel E-1 Direct Runoff	Checked: BREKEME	Date: 8/20/2015

Check one: ❑ Present ❑ Under Development ■ Developed

Hydrologic Group	Cover Description	CN			Area	Product of CN x Area
		Table 2-2*	Figure 2-3	Figure 2-4	■ Acres ❑ miles^2 ❑ %	
B	Bare Soil (Dirt)	82			8.7	713
B	Meadow	58			2.2	130
C	Gravel	91			1.0	95
			TOTALS		**12.0**	**939**

CN (weighted) = Total Product / Total Area

CN	**78**

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

Runoff Curve Number

Project:	By:	Date:
Possum Point Pond Closures - H&H Calculations	BRENDCF	8/20/2015
C150132.00	Checked:	Date:
Location:	BREKEME	8/20/2015
Pond E, Channel E-2 Direct Runoff		

Check one: ❑ Present ❑ Under Development ■ Developed

Hydrologic Group	Cover Description	CN			Area	Product of CN x Area
		Table 2-2*	Figure 2-3	Figure 2-4	■ Acres ❑ $miles^2$ ❑ %	
B	Bare Soil (Dirt)	82			11.3	924
A	Meadow	30			0.9	27
B	Meadow	58			0.5	29
			TOTALS		**12.7**	**980**

CN (weighted) = Total Product / Total Area

CN	**77**

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

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Runoff Curve Number

Project:	By:	Date:
Possum Point Pond Closures - H&H Calculations	BRENDCF	8/20/2015
C150132.00	Checked:	Date:
Location:	BREKEME	8/20/2015
Pond E, Channel E-3 Direct Runoff		

Check one: ❑ Present ❑ Under Development ■ Developed

Hydrologic Group	Cover Description	CN			Area	Product of CN x Area
		Table 2-2*	Figure 2-3	Figure 2-4	■ Acres ❑ $miles^2$ ❑ %	
B	Bare Soil (Dirt)	82			14.9	1,224
A	Meadow	30			0.2	5
B	Meadow	58			0.5	28
B	Woods (fair)	60			0.05	3
C	Gravel	91			0.9	82
			TOTALS		**16.5**	**1,342**

CN (weighted) = Total Product / Total Area

CN	**81**

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

893

Runoff Curve Number

Project: Possum Point Pond Closures - H&H Calculations C150132.00	By: BRENDCF	Date: 8/20/2015
Location: Pond E, Outlet Channel Direct Runoff	Checked: BREKEME	Date: 8/20/2015

Check one: ❑ Present ❑ Under Development ■ Developed

Hydrologic Group	Cover Description	CN			Area	Product of CN x Area
		Table 2-2*	Figure 2-3	Figure 2-4	■ Acres ❑ miles^2 ❑ %	
B	Bare Soil (Dirt)	82			4.3	353
A	Meadow	30			0.05	1.4
B	Meadow	58			0.1	5.9
B	Woods (fair)	60			0.05	3.0
C	Gravel	91			0.2	18
			TOTALS		**4.7**	**381**

CN (weighted) = Total Product / Total Area

CN	**81**

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

Runoff Curve Number

Project: Possum Point Pond Closures - H&H Calculations C150132.00	By: SCHELAB	Date: 6/22/2015
Location: Pond E, Metals Diversion B	Checked: BERKEME	Date: 6/23/2015

Check one: ❑ Present ■ Under Development ❑ Developed

Hydrologic Group	Cover Description	CN			Area	Product of CN x Area
		Table 2-2*	Figure 2-3	Figure 2-4	■ Acres ❑ $miles^2$ ❑ %	
A	Woods (fair)	36			4.4	159
B	Woods (fair)	60			0.6	39
B	Bare Soil (Dirt)	82			20.7	1,699
A	Meadow	30			2.9	88
B	Meadow	58			5.1	295
			TOTALS		**33.8**	**2,280**

CN (weighted) = Total Product / Total Area | **CN** | **67**

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

Runoff Curve Number

Project:	By:	Date:
Possum Point Pond Closures - H&H Calculations	SCHELAB	6/22/2015
C150132.00	Checked:	Date:
Location:	BERKEME	6/22/2015
Pond E, Metals Diversion C		

Check one: ❑ Present ■ Under Development ❑ Developed

Hydrologic Group	Cover Description	CN			Area	Product of CN x Area
		Table 2-2*	Figure 2-3	Figure 2-4	■ Acres ❑ miles² ❑ %	
A	Woods (fair)	36			0.06	2.3
B	Woods (fair)	60			1.6	95
B	Meadow	58			0.8	45
			TOTALS		**2.4**	**143**

CN (weighted) = Total Product / Total Area

CN	**59**

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

Runoff Curve Number

Project: Possum Point Pond Closures - H&H Calculations C150132.00	By: BERKEME	Date: 7/30/2015
	Checked: SCHELAB	Date: 8/11/2015
Location: Pond E, Channel E-4		

Check one: ☐ Present ■ Under Development ☐ Developed

Hydrologic Group	Cover Description	CN: Table 2-2*	CN: Figure 2-3	CN: Figure 2-4	Area ■ Acres ☐ miles^2 ☐ %	Product of CN x Area
N/A	Riprap Area	89			0.1	9
A	Meadow	30			0.5	14
B	Meadow	58			0.9	51
B	Bare Soil (Dirt)	82			2.2	177
			TOTALS		**3.6**	**251**

CN (weighted) = Total Product / Total Area

CN	**70**

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

Runoff Curve Number

Project: Possum Point Pond Closures - H&H Calculations C150132.00	By: BERKEME	Date: 7/30/2015
Location: Pond E, Channel E-5	Checked: SCHELAB	Date: 8/11/2015

Check one: ❑ Present ■ Under Development ❑ Developed

Hydrologic Group	Cover Description	CN			Area	Product of CN x Area
		Table 2-2*	Figure 2-3	Figure 2-4	■ Acres ❑ $miles^2$ ❑ %	
N/A	Riprap Area	89			0.1	5
A	Meadow	30			0.3	9
B	Meadow	58			0.7	39
B	Woods	60			0.4	27
B	Bare Soil (Dirt)	82			2.3	190
			TOTALS		**3.8**	**270**

CN (weighted) = Total Product / Total Area

CN	**71**

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

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Runoff Curve Number

Project: Possum Point Pond Closures - H&H Calculations C150132.00		By: BERKEME	Date: 7/30/2015
		Checked: SCHELAB	Date: 8/11/2015
Location: Pond E, Channel E-6			

Check one: ❑ Present ■ Under Development ❑ Developed

Hydrologic Group	Cover Description	CN: Table 2-2*	CN: Figure 2-3	CN: Figure 2-4	Area ■ Acres ❑ miles^2 ❑ %	Product of CN x Area
N/A	Riprap Area	89			0.2	16
A	Meadow	30			2.3	69
B	Meadow	58			2.6	153
B	Woods	60			3.6	218
				TOTALS	**8.7**	**455**

CN (weighted) = Total Product / Total Area

CN	**52**

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

SUBJECT POSSUM POINT CCR POND CLOSURES

SITE HYDROLOGIC ANALYSES

BY SCHELAB DATE 06/28/2015 PROJ. NO. C150132.00

CHKD. BY BERKEME DATE 07/9/2015

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ATTACHMENT 4

NOAA RAINFALL DATA

NOAA Atlas 14, Volume 2, Version 3
Location name: Dumfries, Virginia, US*
Latitude: 38.5352°, Longitude: -77.2816°
Elevation: 30 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

PF tabular | PF graphical | Maps & aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.357 (0.323-0.393)	0.428 (0.387-0.472)	0.509 (0.460-0.561)	0.568 (0.512-0.626)	0.643 (0.576-0.709)	0.699 (0.624-0.771)	0.755 (0.670-0.834)	0.810 (0.713-0.896)	0.880 (0.766-0.979)	0.934 (0.808-1.04)
10-min	0.570 (0.516-0.629)	0.685 (0.620-0.755)	0.815 (0.737-0.898)	0.909 (0.820-1.00)	1.03 (0.918-1.13)	1.11 (0.993-1.23)	1.20 (1.06-1.33)	1.28 (1.13-1.42)	1.39 (1.21-1.55)	1.47 (1.27-1.65)
15-min	0.713 (0.645-0.786)	0.861 (0.779-0.949)	1.03 (0.932-1.14)	1.15 (1.04-1.27)	1.30 (1.16-1.43)	1.41 (1.26-1.56)	1.52 (1.35-1.68)	1.62 (1.43-1.79)	1.75 (1.53-1.95)	1.85 (1.60-2.06)
30-min	0.978 (0.884-1.08)	1.19 (1.08-1.31)	1.47 (1.32-1.62)	1.67 (1.50-1.84)	1.93 (1.72-2.12)	2.12 (1.89-2.34)	2.32 (2.06-2.57)	2.52 (2.22-2.79)	2.79 (2.43-3.10)	2.99 (2.59-3.34)
60-min	1.22 (1.10-1.34)	1.49 (1.35-1.64)	1.88 (1.70-2.07)	2.17 (1.96-2.39)	2.56 (2.30-2.83)	2.88 (2.57-3.17)	3.20 (2.84-3.53)	3.54 (3.11-3.91)	4.00 (3.48-4.45)	4.37 (3.78-4.88)
2-hr	1.42 (1.28-1.58)	1.73 (1.56-1.92)	2.20 (1.98-2.43)	2.56 (2.30-2.83)	3.07 (2.74-3.39)	3.49 (3.10-3.85)	3.92 (3.46-4.34)	4.39 (3.84-4.86)	5.04 (4.36-5.61)	5.57 (4.77-6.23)
3-hr	1.53 (1.38-1.72)	1.87 (1.68-2.09)	2.37 (2.12-2.64)	2.77 (2.47-3.08)	3.33 (2.96-3.71)	3.80 (3.35-4.23)	4.30 (3.76-4.78)	4.82 (4.18-5.38)	5.58 (4.77-6.25)	6.20 (5.24-6.97)
6-hr	1.89 (1.70-2.12)	2.29 (2.06-2.56)	2.89 (2.59-3.23)	3.38 (3.02-3.78)	4.11 (3.64-4.59)	4.72 (4.15-5.28)	5.39 (4.69-6.02)	6.11 (5.26-6.84)	7.17 (6.08-8.07)	8.06 (6.73-9.11)
12-hr	2.29 (2.05-2.58)	2.76 (2.47-3.11)	3.51 (3.13-3.95)	4.14 (3.68-4.65)	5.10 (4.49-5.72)	5.94 (5.17-6.66)	6.87 (5.91-7.70)	7.90 (6.71-8.88)	9.46 (7.88-10.7)	10.8 (8.86-12.3)
24-hr	2.57 (2.34-2.89)	3.12 (2.83-3.50)	4.04 (3.66-4.52)	4.84 (4.37-5.40)	6.06 (5.43-6.74)	7.14 (6.35-7.90)	8.35 (7.37-9.21)	9.73 (8.50-10.7)	11.8 (10.2-13.0)	13.7 (11.6-15.0)
2-day	2.99 (2.70-3.33)	3.63 (3.29-4.04)	4.68 (4.24-5.21)	5.59 (5.04-6.21)	6.96 (6.24-7.70)	8.16 (7.27-9.00)	9.49 (8.38-10.5)	11.0 (9.62-12.1)	13.3 (11.4-14.6)	15.2 (13.0-16.7)
3-day	3.17 (2.88-3.53)	3.84 (3.49-4.28)	4.95 (4.48-5.50)	5.90 (5.32-6.54)	7.32 (6.56-8.09)	8.56 (7.63-9.43)	9.93 (8.78-10.9)	11.5 (10.1-12.6)	13.8 (11.9-15.1)	15.8 (13.5-17.3)
4-day	3.35 (3.05-3.72)	4.06 (3.69-4.52)	5.21 (4.73-5.79)	6.20 (5.61-6.87)	7.67 (6.89-8.48)	8.95 (8.00-9.87)	10.4 (9.19-11.4)	11.9 (10.5-13.1)	14.3 (12.4-15.7)	16.3 (14.0-17.9)
7-day	3.90 (3.57-4.28)	4.70 (4.30-5.16)	5.95 (5.44-6.53)	7.00 (6.39-7.69)	8.58 (7.80-9.40)	9.93 (8.97-10.9)	11.4 (10.2-12.5)	13.1 (11.6-14.2)	15.5 (13.6-16.9)	17.6 (15.2-19.1)
10-day	4.46 (4.11-4.87)	5.36 (4.93-5.86)	6.69 (6.15-7.30)	7.79 (7.15-8.49)	9.39 (8.57-10.2)	10.7 (9.76-11.7)	12.2 (11.0-13.2)	13.7 (12.3-14.9)	16.0 (14.2-17.3)	17.8 (15.7-19.4)
20-day	6.01 (5.59-6.49)	7.16 (6.65-7.73)	8.65 (8.04-9.33)	9.86 (9.15-10.6)	11.6 (10.7-12.4)	12.9 (11.9-13.9)	14.3 (13.2-15.4)	15.8 (14.5-17.0)	17.9 (16.2-19.2)	19.5 (17.6-21.0)
30-day	7.39 (6.89-7.92)	8.74 (8.17-9.36)	10.4 (9.71-11.2)	11.7 (10.9-12.6)	13.6 (12.6-14.5)	15.0 (13.9-16.0)	16.5 (15.2-17.6)	18.0 (16.6-19.2)	20.0 (18.3-21.4)	21.6 (19.7-23.1)
45-day	9.29 (8.72-9.86)	11.0 (10.3-11.6)	12.8 (12.0-13.6)	14.3 (13.4-15.1)	16.1 (15.1-17.1)	17.6 (16.4-18.6)	19.0 (17.7-20.1)	20.4 (18.9-21.6)	22.1 (20.5-23.5)	23.5 (21.7-25.0)
60-day	11.0 (10.4-11.7)	13.0 (12.2-13.7)	15.0 (14.1-15.9)	16.5 (15.6-17.4)	18.5 (17.4-19.5)	19.9 (18.7-21.0)	21.3 (19.9-22.5)	22.6 (21.1-23.9)	24.2 (22.6-25.7)	25.4 (23.6-26.9)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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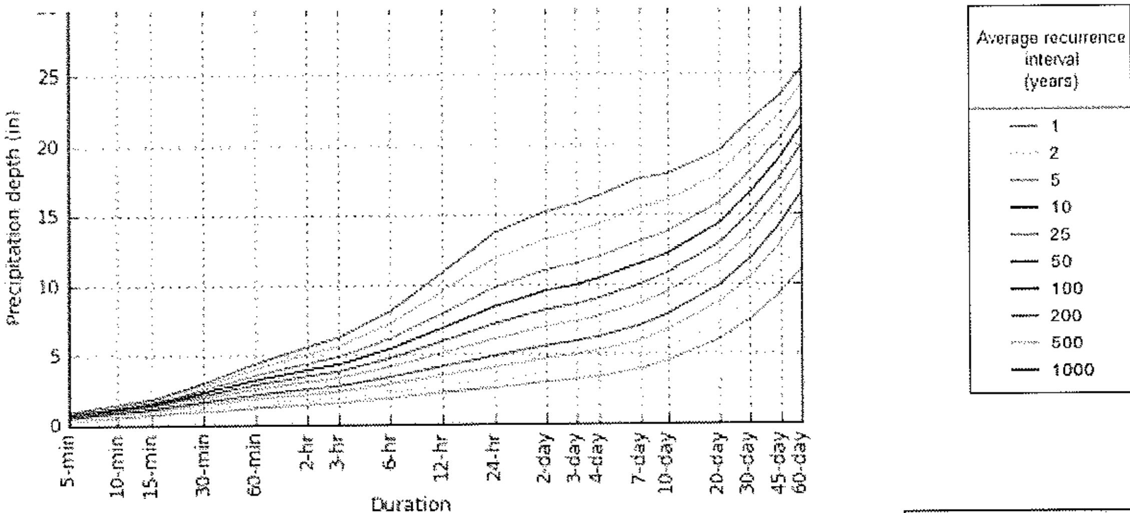
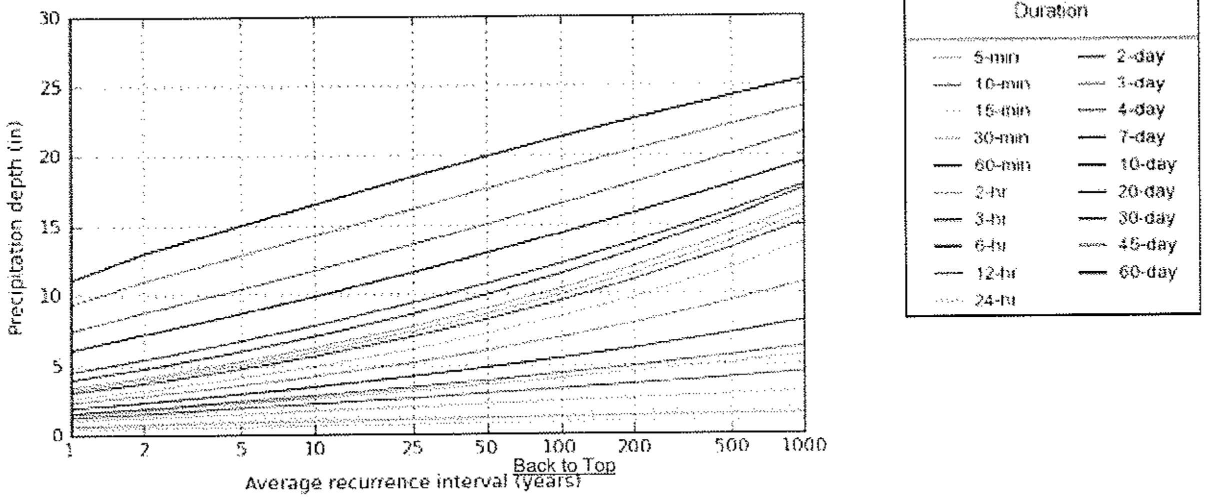
PF graphical





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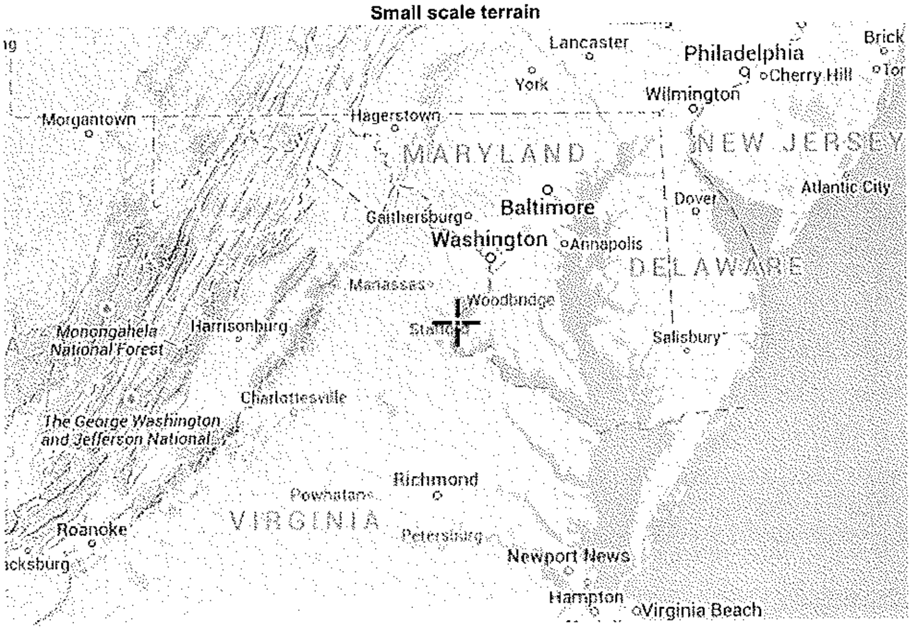
NOAA Atlas 14, Volume 2, Version 3

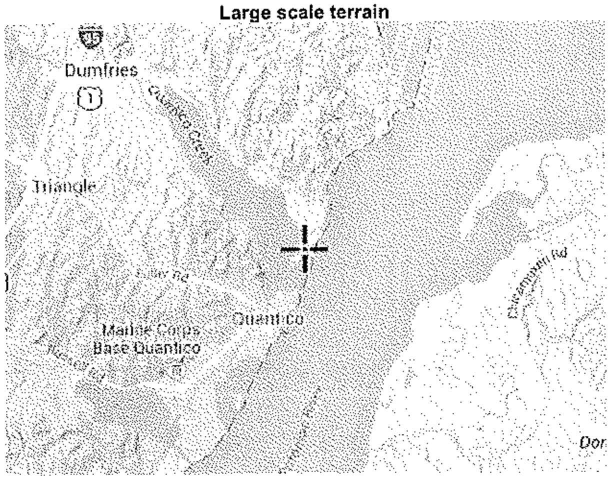
Created (GMT): Mon Mar 9 13:33:02 2015

Maps & aerials

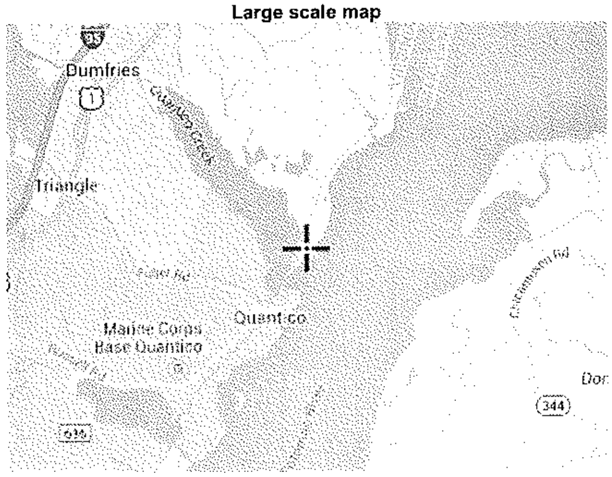
Small scale terrain



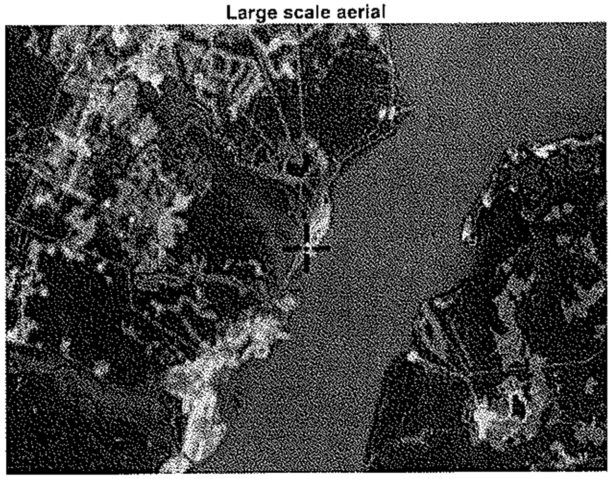
Large scale terrain



Large scale map



Large scale aerial



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US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
Office of Hydrologic Development
1325 East West Highway
Silver Spring, MD 20910

SUBJECT POSSUM POINT CCR POND CLOSURES
SITE HYDROLOGIC ANALYSES

BY SCHELAB DATE 06/28/2015 PROJ. NO. C150132.00

CHKD. BY BERKEME DATE 07/9/2015

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ATTACHMENT 5

PMP EVALUATION

SUBJECT DOMINION – POSSUM POINT CCR POND CLOSURES
PMP PRECIPITATION DISTRIBUTIONS

BY SCHELAB DATE 03/30/2015 PROJ. NO. C150132.00

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INTRODUCTION

The three inactive CCR impoundments that previously supported the Possum Point Generating Station are regulated as dams by the Virginia Department of Conservation and Recreation (DCR). Using National Oceanic and Atmospheric Administration/National Weather Service documents, this calculation will determine the Probable Maximum Precipitation (PMP) at the site for a variety of storm durations. Due to the proximity of the ponds, the identified PMP will be applicable to all three Ponds.

PRECIPITATION

The National Weather Service's *Hydrometeorological Report No. 51 (HMR-51), "Probable Maximum Precipitation Estimates, United States East of the 105th Meridian"* contains charts that show the PMP for watersheds of various sizes and for various durations. The charts for the PMP for a 10-square mile watershed are attached on the next 3 pages, and they show the PMP for a 6-hour, 12-hour, 24-hour, 48-hour, and 72-hour storm.

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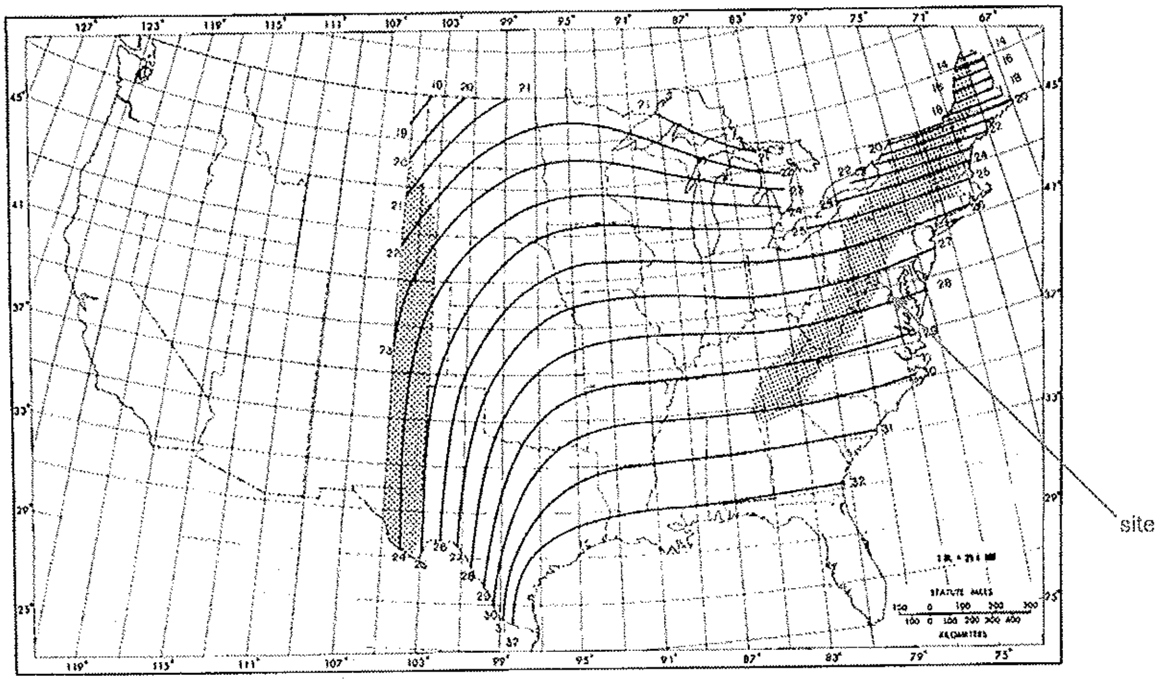

Figure 18.--All-season PMP (in.) for 6 hr 10 mi^2 (26 km^2).

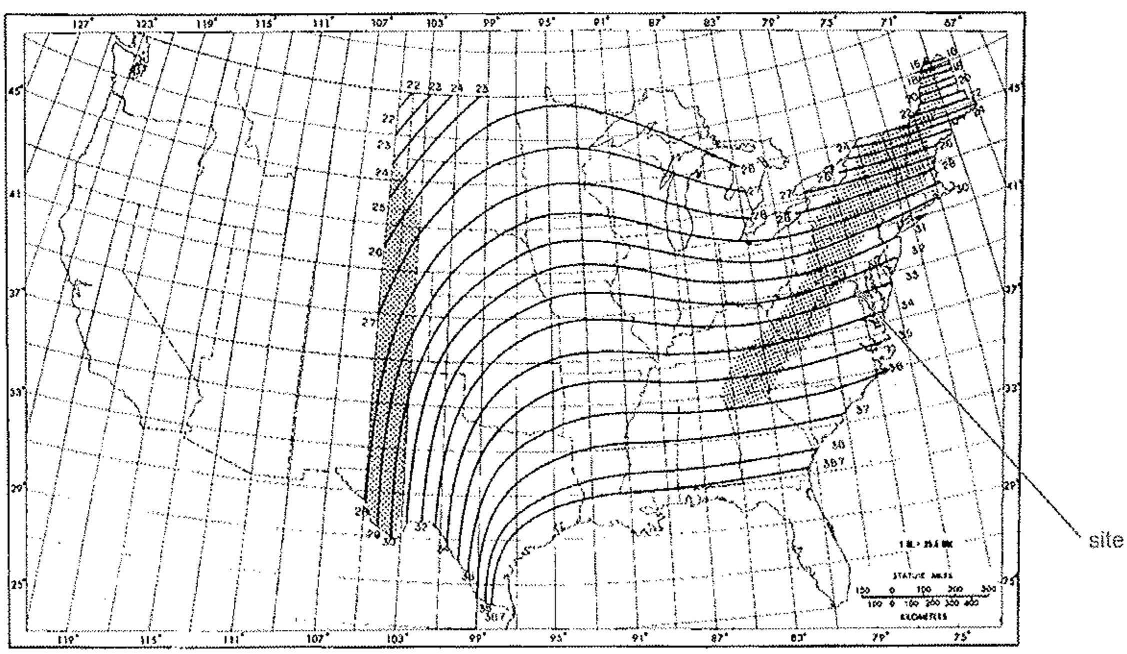

Figure 19.--All-season PMP (in.) for 12 hr 10 mi^2 (26 km^2).

SUBJECT DOMINION – POSSUM POINT CCR POND CLOSURES
PMP PRECIPITATION DISTRIBUTIONS

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CHKD. BY BERKEME DATE 8/7/2015 SHEET NO. 3 OF 6

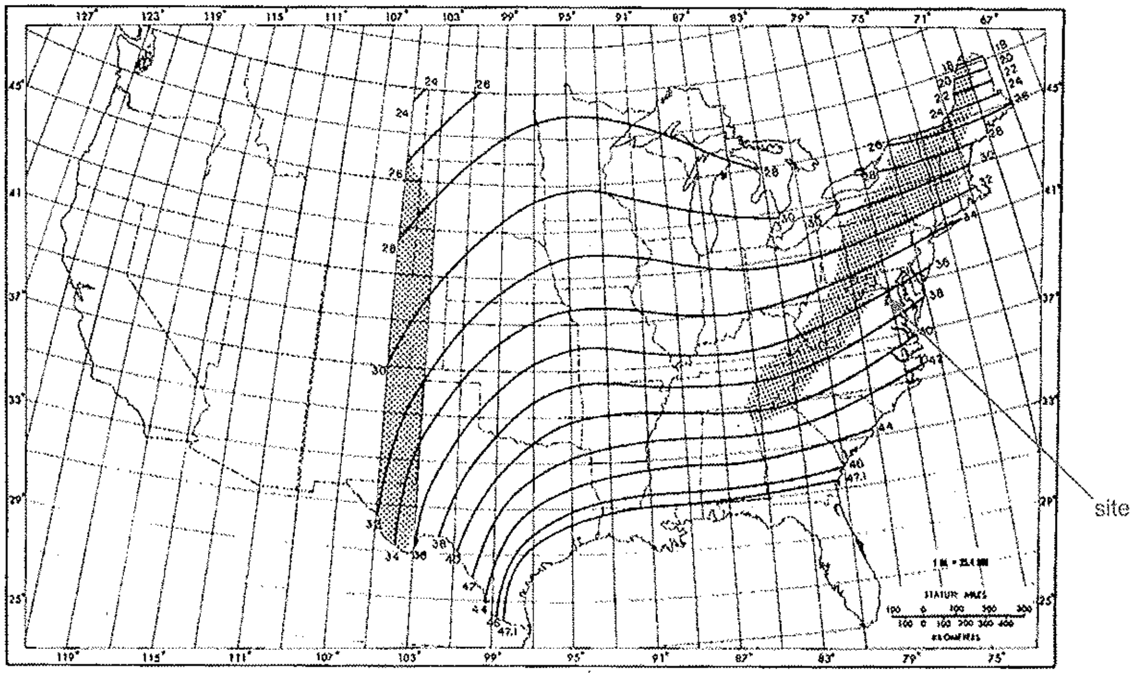

Figure 20.--All-season PMP (in.) for 24 hr 10 mi^2 (26 km^2).

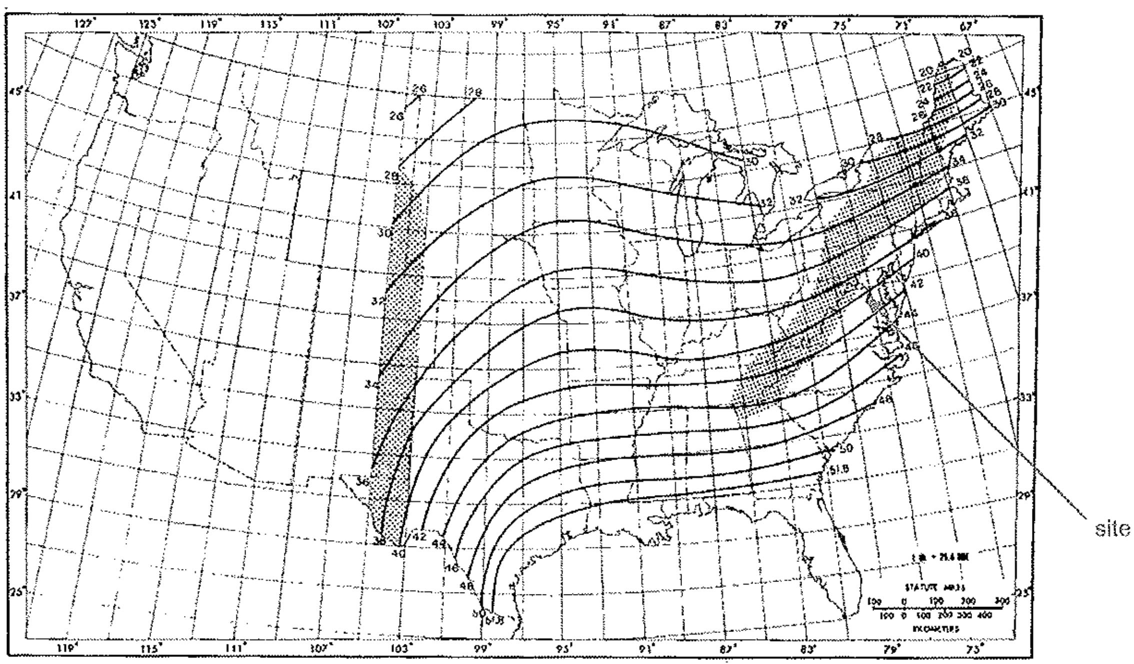

Figure 21.--All-season PMP (in.) for 48 hr 10 mi^2 (26 km^2).

SUBJECT DOMINION – POSSUM POINT CCR POND CLOSURES
PMP PRECIPITATION DISTRIBUTIONS

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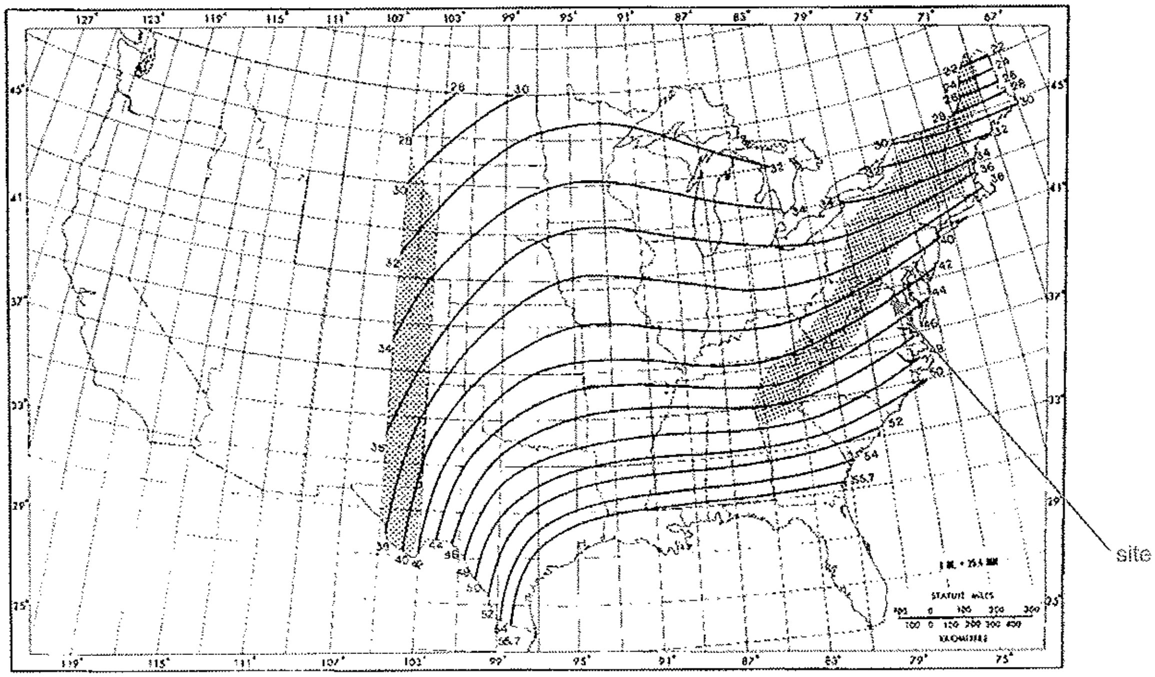

Figure 22.--All-season PMP (in.) for 72 hr 10 mi² (26 km²).

From the above charts, the PMP for a 10 square mile watershed can be summarized as:

6-hour PMP	27.8 inches
12-hour PMP	32.8 inches
24-hour PMP	36.7 inches
48-hour PMP	40.8 inches
72-hour PMP	42.0 inches

SUBJECT DOMINION – POSSUM POINT CCR POND CLOSURES
PMP PRECIPITATION DISTRIBUTIONS

BY SCHELAB DATE 03/30/2015 PROJ. NO. C150132.00

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PRECIPITATION continued

To perform hydrologic assessments of the PMP event, it is necessary to develop a rainfall mass curve for time intervals less than the 6-hour storm documented previously.

The 1973 edition of *"Design of Small Dams"* (U.S. Bureau of Reclamation) contains the following chart to distribute precipitation for a 6-hour event. As noted, Zone C is appropriate for areas east of the 105° meridian, which is the Mountain time zone longitude near Pike's Peak in the Rocky Mountains. The Possum Point site is east of this location, so the use of Zone C is appropriate.

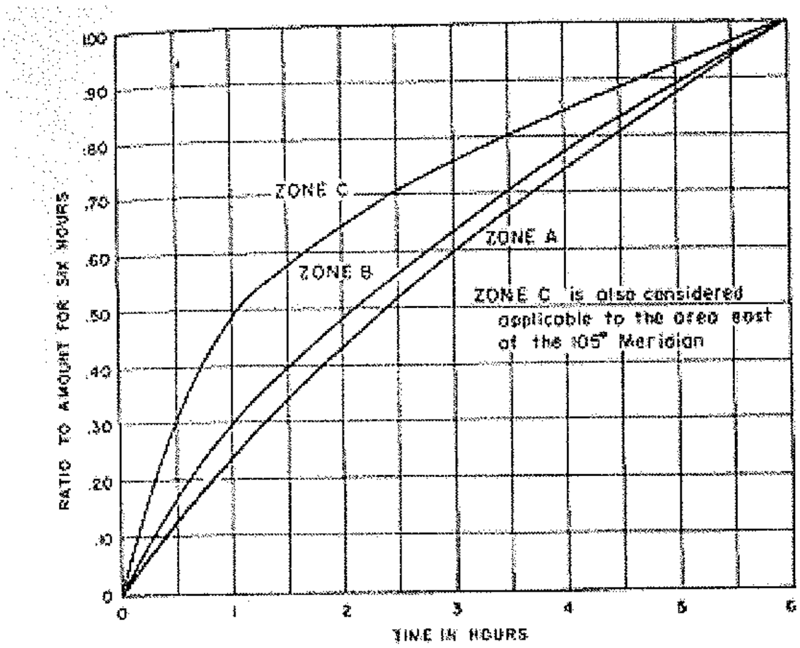

Figure 18. Distribution of 6-hour rainfall for area west of 105° meridian. See figure 17 for area included within each zone. 288–D–2758.

Time	Ratio to 6-hour amount	PMP (inches)
15 minutes	0.15	4.2
1 hour	0.48	13.3
2 hours	0.65	18.1
3 hours	0.75	20.9
6 hours	1.00	27.8

Z:\Energy\2015\C150132.00 - DOM - Possum Point PS CCB\Working Docs\ENGINEERING\H & H\PMP Evaluation\PMP precipitation.doc

SUBJECT DOMINION – POSSUM POINT CCR POND CLOSURES
PMP PRECIPITATION DISTRIBUTIONS

BY SCHELAB DATE 03/30/2015 PROJ. NO. C150132.00

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The 12-hour and 24-hour PMP precipitation distributions are extensions of the 6-hour distribution, as follows:

Rainfall Duration	PMP (inches)
15 minutes	4.2
1 hour	13.3
2 hours	18.1
3 hours	20.9
6 hours	27.8
12 hours	32.8
24 hours	36.7

STORM DESIGN DURATION

The Virginia Dam Safety regulations state that the 6-, 12-, and 24-hour design storms must be evaluated and the largest peak outflow used for dam design.

SUBJECT POSSUM POINT CCR POND CLOSURES
SITE HYDROLOGIC ANALYSES
BY SCHELAB DATE 06/28/2015 PROJ. NO. C150132.00
CHKD. BY BERKEME DATE 07/9/2015

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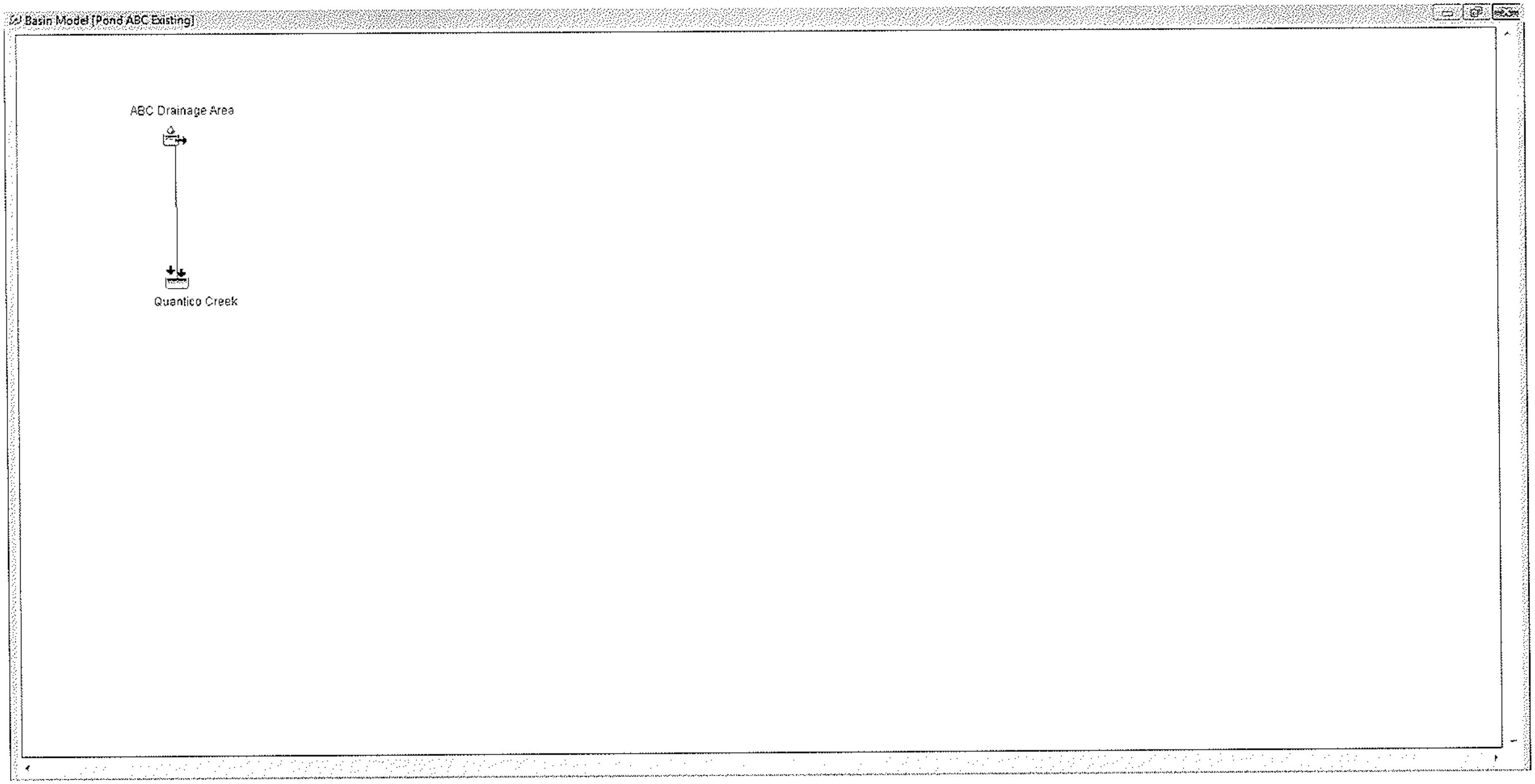
ATTACHMENT 6

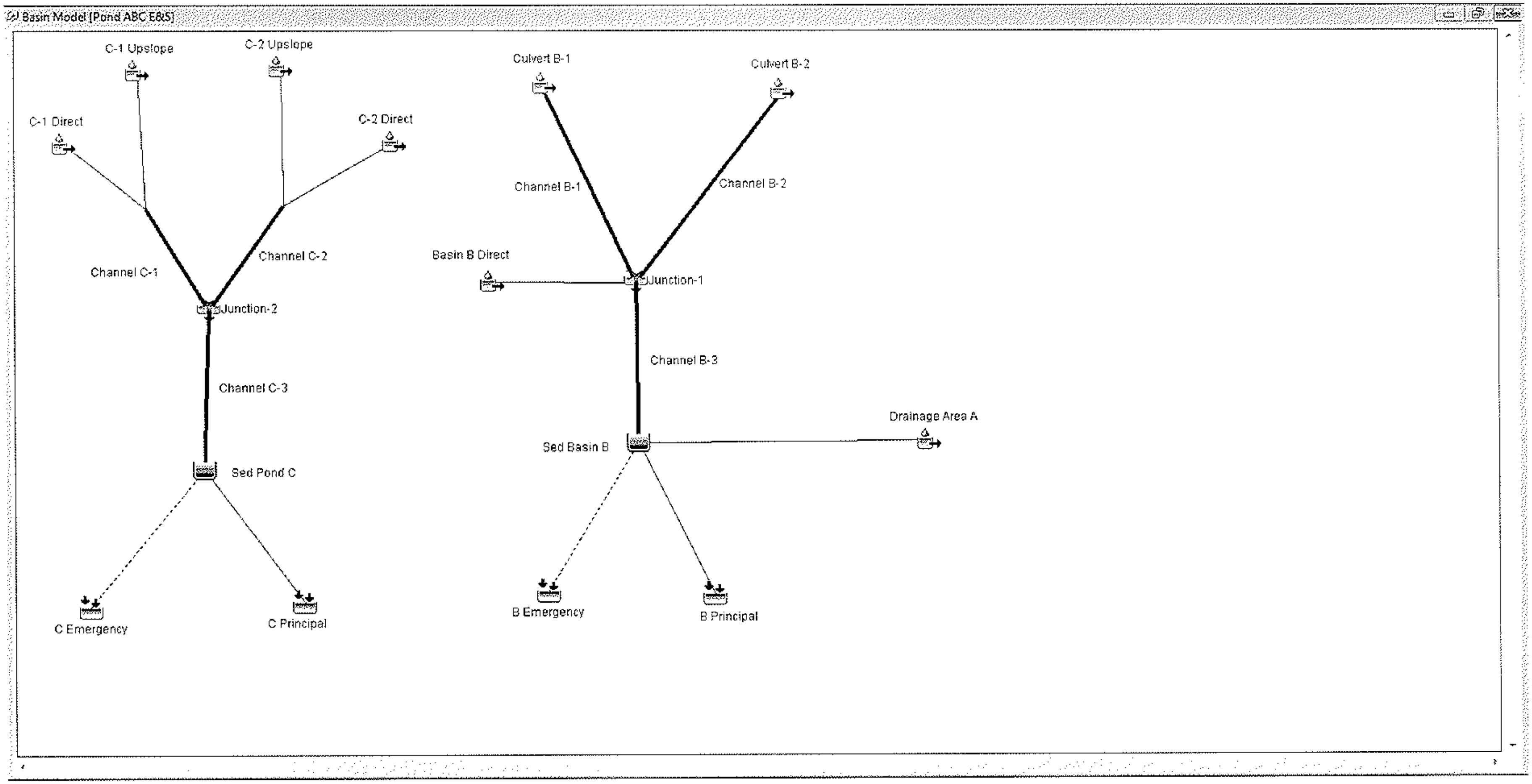
HEC-HMS INPUT



EXISTING CONDITIONS

POND ABC

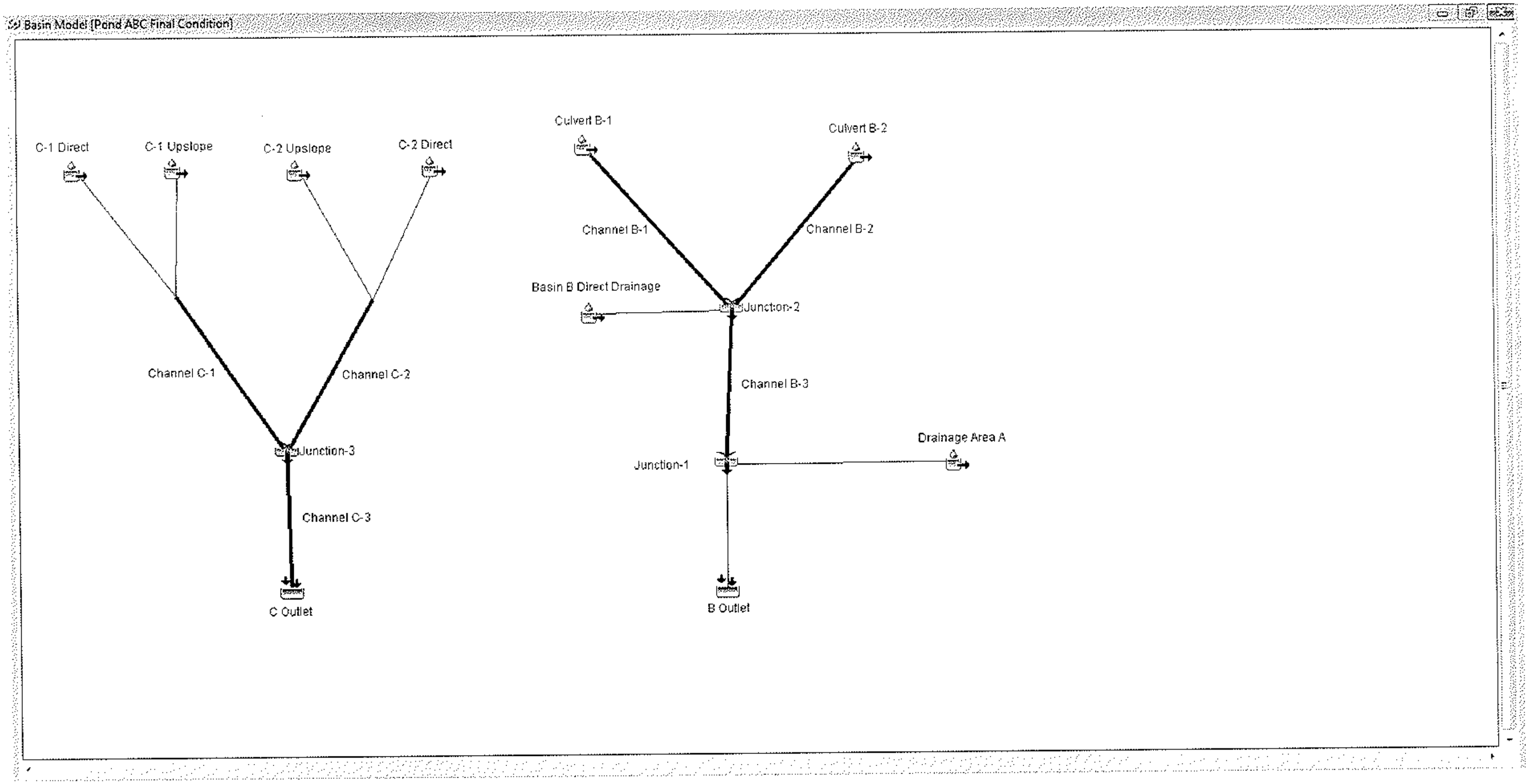
HEC-HMS MODEL SCHEMATIC



DURING CONSTRUCTION (E&S) CONDITIONS

POND ABC

HEC-HMS MODEL SCHEMATIC



POST CONSTRUCTION (FINAL) CONDITIONS

POND ABC

HEC-HMS MODEL SCHEMATIC

HEC-HMS Report of Input Fields
Loss Method : SCS Curve Number
Transform Method : SCS Unit Hydrograph

- - - - - - - - - - - - - - - - - -

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Model Summary

Hydrologic Input Data

Basin Model: Pond ABC Existing
Description:
Version: 4.0
Units: English

Summary Table

Name	Area (sq mi)	Loss Method	% Imper.	CN	Transform Method	SCS lag (min)
ABC Drainage Area	0.0570312	SCS	0	57	SCS	8.4

File Last Modified 20 August 201502:43:04

EXISTING CONDITIONS

POND ABC

HEC-HMS MODEL INPUT SUMMARY

HEC-HMS Report of Input Fields
Loss Method : SCS Curve Number
Transform Method : SCS Unit Hydrograph

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Model Summary

Hydrologic Input Data

Basin Model: Pond ABC E&S
Description:
Version: 4.0
Units: English

Summary Table

Name	Area (sq mi)	Loss Method	% imper.	CN	Transform Method	SCS lag (min)
Drainage Area A	0.003698	SCS	0	81	SCS	5.4
Culvert B-1	0.013207	SCS	0	54	SCS	8.4
Culvert B-2	0.003146	SCS	0	63	SCS	3.6
Basin B Direct	0.012377	SCS	0	79	SCS	3.6
C-1 Upslope	0.009299	SCS	0	51	SCS	6
C-1 Direct	0.0046875	SCS	0	82	SCS	3.6
C-2 Upslope	0.0039062	SCS	0	58	SCS	6
C-2 Direct	0.0065625	SCS	0	82	SCS	3.6

File Last Modified 26 August 2015 11:39:14

DURING CONSTRUCTION (E&S) CONDITIONS

POND ABC

HEC-HMS MODEL INPUT SUMMARY

HEC-HMS Report of Input Fields
Loss Method : SCS Curve Number
Transform Method : SCS Unit Hydrograph

SCHELAB - GAI Consultants

Model Summary

Hydrologic Input Data

Basin Model: Pond ABC Final Condition
Description:
Version: 4.0
Units: English

Summary Table

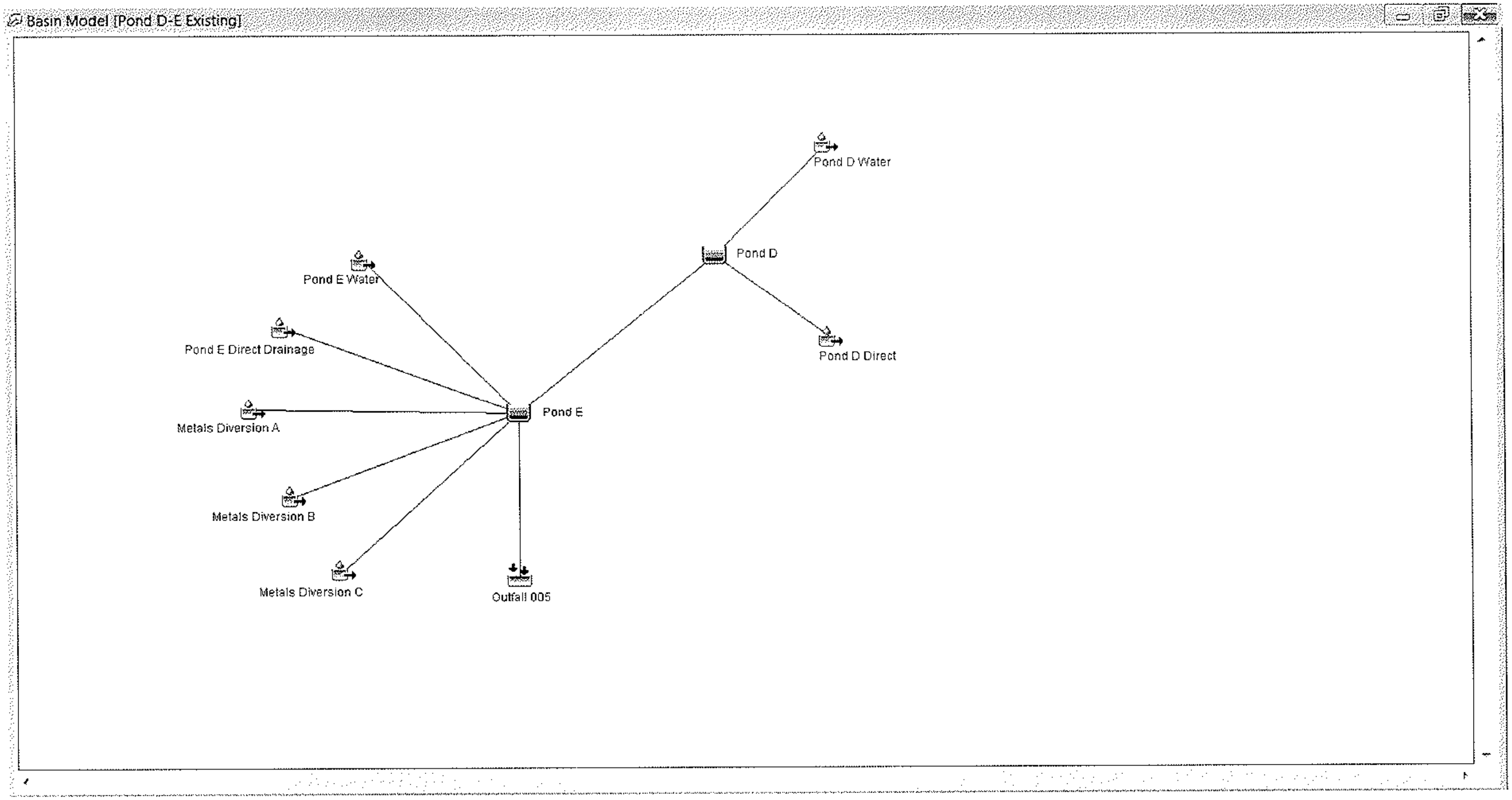
Name	Area (sq mi)	Loss Method	% Imper.	CN	Transform Method	SCS lag (min)
Drainage Area A	0.003698	SCS	0	59	SCS	5.4
Culvert B-1	0.013207	SCS	0	54	SCS	8.4
Culvert B-2	0.003146	SCS	0	55	SCS	3.6
Basin B Direct Drainage	0.012377	SCS	0	58	SCS	3.6
C-1 Upslope	0.009299	SCS	0	51	SCS	6
C-1 Direct	0.0048875	SCS	0	58	SCS	3.5
C-2 Upslope	0.0039062	SCS	0	58	SCS	6
C-2 Direct	0.0065625	SCS	0	58	SCS	3.6

File Last Modified 26 August 2015 11:36:54

POST CONSTRUCTION (FINAL) CONDITIONS

POND ABC

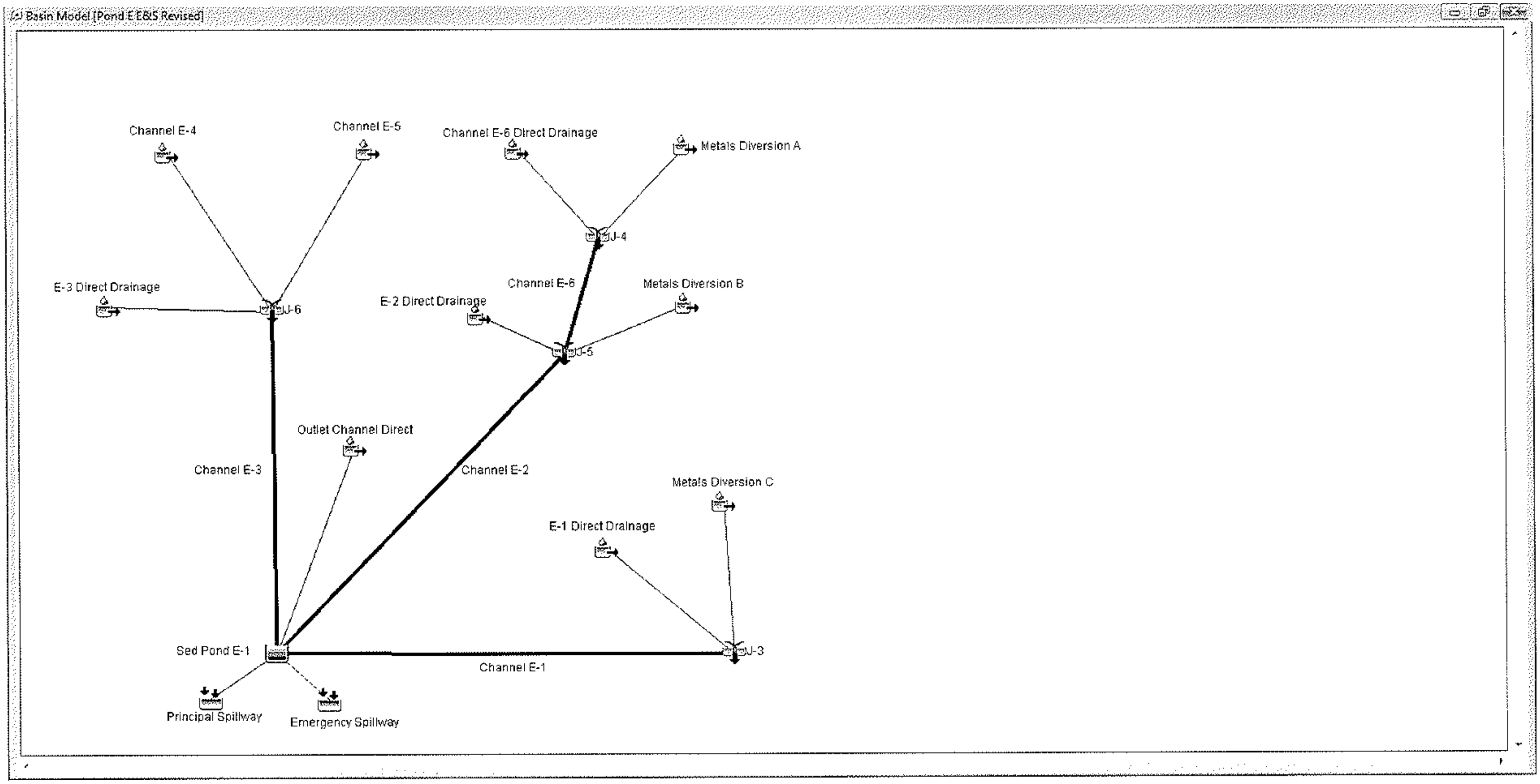
HEC-HMS MODEL INPUT SUMMARY



EXISTING CONDITIONS

PONDS D AND E

HEC-HMS MODEL SCHEMATIC

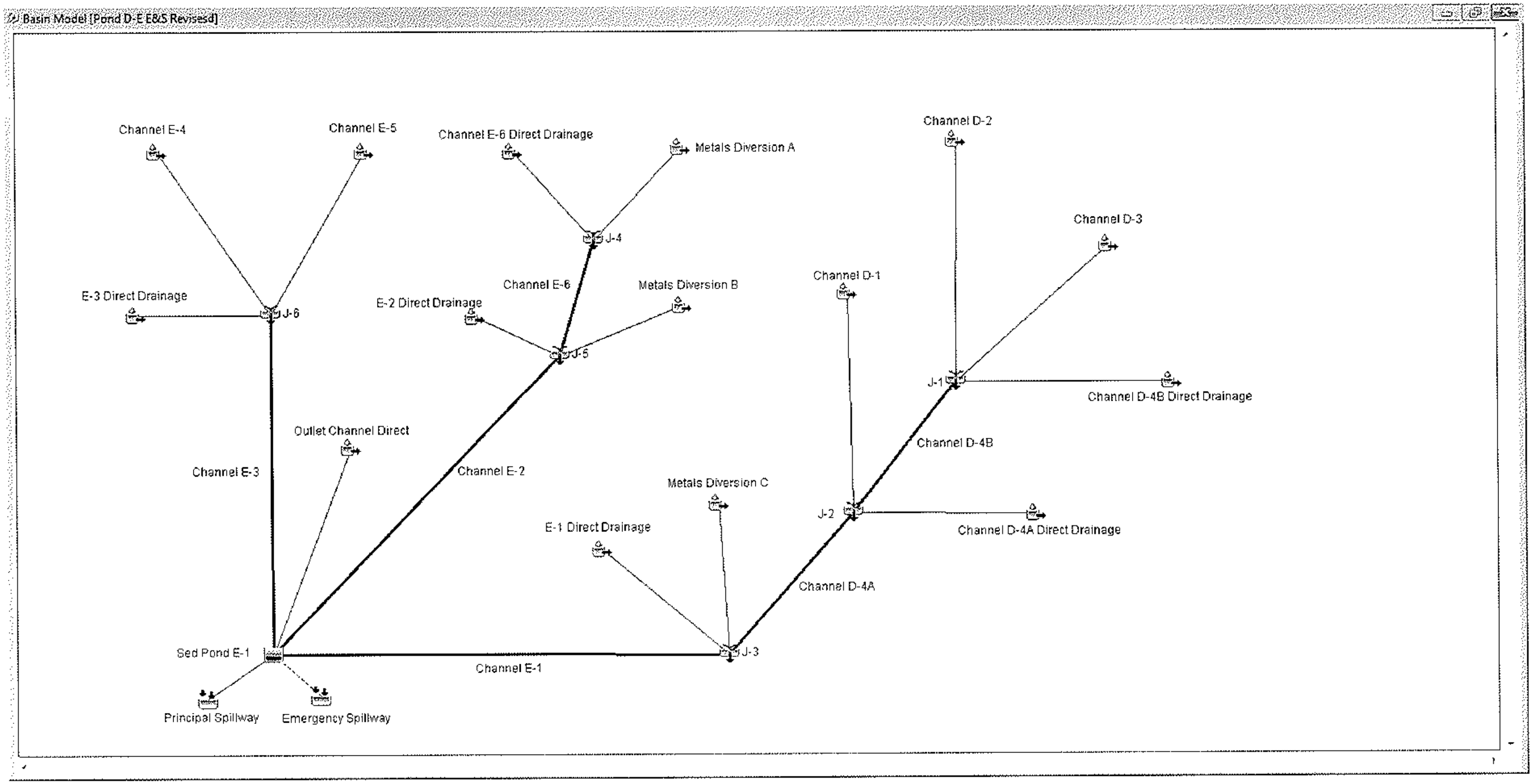


NOTE: IN THIS CONDITION, POND D WHATER IS NOT PERMITTED TO DRAIN INTO POND E. ALL DRAINAGE UPSLOPE OF J-3 WILL BE COLLECTED AND PUMPED TO A PERMITTED OUTFALL.

DURING CONSTRUCTION (E&S) CONDITIONS

POND E

HEC-HMS MODEL SCHEMATIC

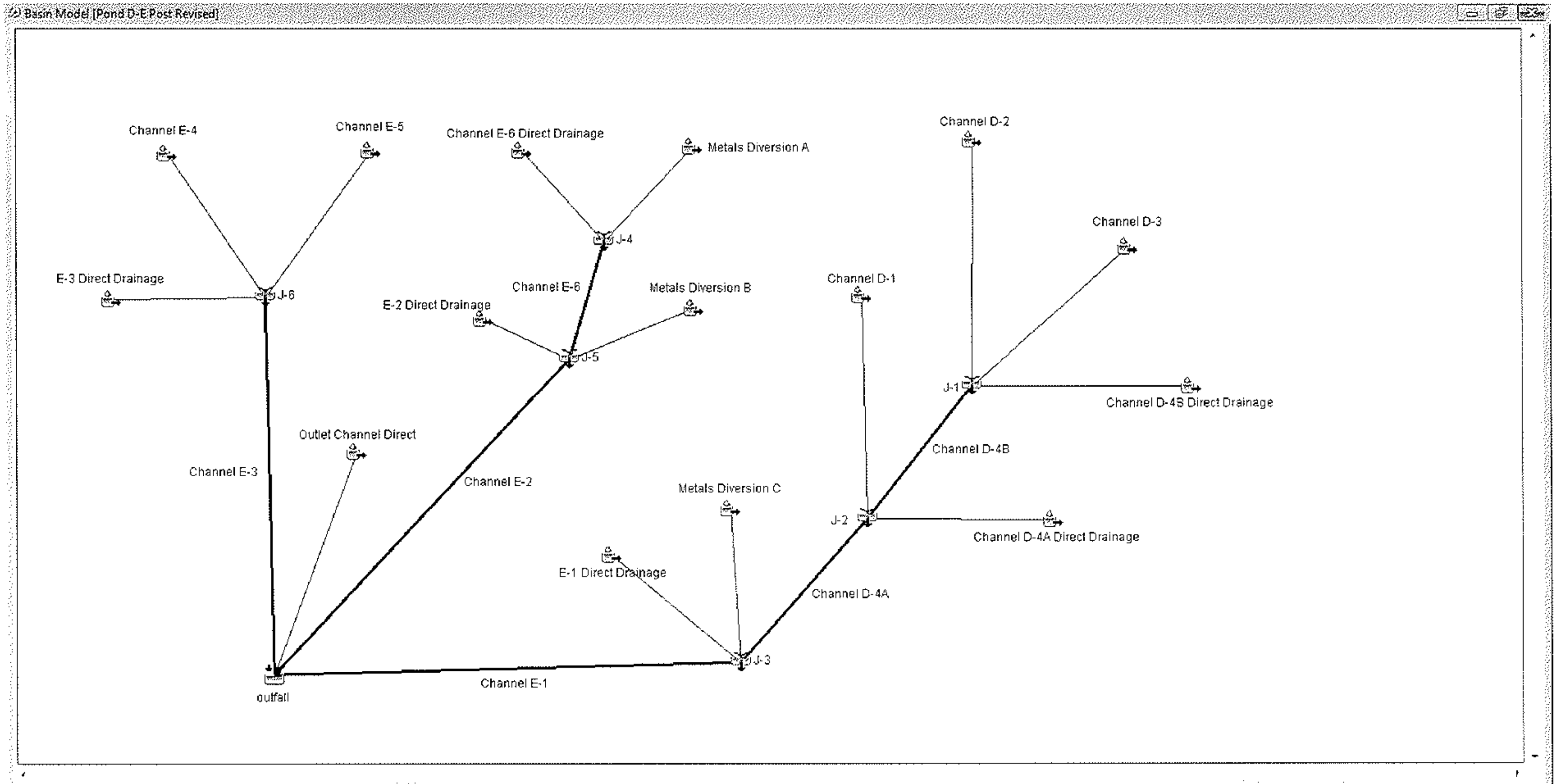


NOTE: IN THIS CONDITION, IT IS ASSUMED THAT DRAINAGE AREAS IN POND E HAVE ESTABLISHED VEGETATION. POND D IS IN A DISTURBED STATE.

DURING CONSTRUCTION (E&S) CONDITIONS

PONDS D AND E

HEC-HMS MODEL SCHEMATIC



POST CONSTRUCTION (FINAL) CONDITIONS

PONDS D AND E

HEC-HMS MODEL SCHEMATIC

HEC-HMS Report of Input Fields
Loss Method : SCS Curve Number
Transform Method : SCS Unit Hydrograph

SCHELAB - GAI Consultants

Model Summary

Hydrologic Input Data

Basin Model: Pond D-E Existing
Description:
Version: 4.0
Units: English

Summary Table

Name	Area (sq mi)	Loss Method	% imper.	CN	Transform Method	SCS lag (min)
Pond D Direct	0.11172	SCS	0	51	SCS	12
Pond D Water	0.0675460	SCS	0	98	SCS	3.6
Pond E Direct Drainage	0.0578125	SCS	0	52	SCS	6.6
Pond E Water	0.045125	SCS	0	98	SCS	3.6
Metals Diversion A	0.0017188	SCS	0	61	SCS	3.6
Metals Diversion B	0.0345312	SCS	0	45	SCS	10.8
Metals Diversion C	0.0073438	SCS	0	59	SCS	5.4

File Last Modified 20 August 2015 01:44:52

EXISTING CONDITIONS

PONDS D AND E

HEC-HMS MODEL INPUT SUMMARY

HEC-HMS Report of Input Fields
Loss Method : SCS Curve Number
Transform Method : SCS Unit Hydrograph
- - - - - - - - - - - - - - - - - -
SCHELAB - GAI Consultants

Model Summary

Hydrologic Input Data

Basin Model: Pond E E&S Revised
Description:
Version: 4.0
Units: English

Summary Table

Name	Area (sq mi)	Loss Method	% imper.	CN	Transform Method	SCS lag (min)
E-1 Direct Drainage	0.0187344	SCS	0	78	SCS	5.4
E-2 Direct Drainage	0.019813	SCS	0	77	SCS	11.4
E-3 Direct Drainage	0.025813	SCS	0	81	SCS	14.4
Channel E-4	0.005625	SCS	0	70	SCS	3.6
Channel E-5	0.0059375	SCS	0	71	SCS	3.6
Channel E-6 Direct Drainage	0.0135937	SCS	0	52	SCS	5.4
Outlet Channel Direct	0.007339	SCS	0	81	SCS	14.4
Metals Diversion A	0.0017185	SCS	0	61	SCS	3.6
Metals Diversion B	0.0528210	SCS	0	67	SCS	10.8
Metals Diversion C	0.0037984	SCS	0	59	SCS	3.6

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NOTE: IN THIS CONDITION, POND D WHATER IS NOT PERMITTED TO DRAIN INTO POND E. ALL DRAINAGE UPSLOPE OF J-3 WILL BE COLLECTED AND PUMPED TO A PERMITTED OUTFALL.

DURING CONSTRUCTION (E&S) CONDITIONS

POND E

HEC-HMS MODEL INPUT SUMMARY

HEC-HMS Report of Input Fields
Loss Method : SCS Curve Number
Transform Method : SCS Unit Hydrograph

- - - - - - - - - - - - - - - - - -

SCHELAB - GAI Consultants

Model Summary

Hydrologic Input Data

Basin Model: Pond D-E E&S Revisesd
Description:
Version: 4.0
Units: English

Summary Table

Name	Area (sq mi)	Loss Method	% imper	CN	Transform Method	SCS lag (min)
Channel D-1	0.0685938	SCS	0	69	SCS	15.6
Channel D-2	0.0367188	SCS	0	81	SCS	12.6
Channel D-3	0.0495312	SCS	0	71	SCS	10.2
Channel D-4B Direct Drainage	0.0092188	SCS	0	82	SCS	7.8
Channel D-4A Direct Drainage	0.0280156	SCS	0	82	SCS	10.2
E-1 Direct Drainage	0.0187344	SCS	0	61	SCS	5.4
E-2 Direct Drainage	0.019813	SCS	0	56	SCS	11.4
E-3 Direct Drainage	0.025813	SCS	0	60	SCS	14.4
Channel E-4	0.005625	SCS	0	55	SCS	3.6
Channel E-5	0.0059375	SCS	0	56	SCS	3.6
Channel E-6 Direct Drainage	0.0135937	SCS	0	52	SCS	5.4
Outlet Channel Direct	0.007339	SCS	0	59	SCS	14.4
Metals Diversion A	0.0017185	SCS	0	61	SCS	3.6
Metals Diversion B	0.0528210	SCS	0	53	SCS	10.8
Metals Diversion C	0.0037984	SCS	0	59	SCS	3.6

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NOTE: IN THIS CONDITION, IT IS ASSUMED THAT DRAINAGE AREAS IN POND E HAVE ESTABLISHED VEGETATION. POND D IS IN A DISTURBED STATE.

DURING CONSTRUCTION (E&S) CONDITIONS

PONDS D AND E

HEC-HMS MODEL INPUT SUMMARY

HEC-HMS Report of Input Fields
Loss Method : SCS Curve Number
Transform Method : SCS Unit Hydrograph

SCHELAB - GAI Consultants

Model Summary

Hydrologic Input Data

Basin Model: Pond D-E Post Revised
Description:
Version: 4.0
Units: English

Summary Table

Name	Area (sq mi)	Loss Method	% Imper.	CN	Transform Method	SCS lag (min)
Channel D-1	0.0685938	SCS	0	56	SCS	15.6
Channel D-2	0.0367188	SCS	0	58	SCS	12.6
Channel D-3	0.0495312	SCS	0	58	SCS	10.2
Channel D-4B Direct Drainage	0.0092188	SCS	0	58	SCS	7.8
Channel D-4A Direct Drainage	0.0280156	SCS	0	58	SCS	10.2
E-1 Direct Drainage	0.0187344	SCS	0	61	SCS	5.4
E-2 Direct Drainage	0.019813	SCS	0	56	SCS	11.4
E-3 Direct Drainage	0.025813	SCS	0	60	SCS	14.4
Channel E-4	0.005625	SCS	0	55	SCS	3.6
Channel E-5	0.0059375	SCS	0	56	SCS	3.5
Channel E-6 Direct Drainage	0.0135937	SCS	0	52	SCS	5.4
Metals Diversion A	0.0017185	SCS	0	61	SCS	3.6
Metals Diversion B	0.0528210	SCS	0	53	SCS	10.8
Metals Diversion C	0.0037984	SCS	0	59	SCS	3.6
Outlet Channel Direct	0.007339	SCS	0	59	SCS	14.4

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POST CONSTRUCTION (FINAL) CONDITIONS

PONDS D AND E

HEC-HMS MODEL INPUT SUMMARY

EXISTING POND D
Elevation Area Curve
(Developed from Bathymetric Survey)

Paired Data | Table | Graph

Elevation (FT)	Area (AC)
87.000	0.00000
88.000	0.15000
90.000	0.58000
92.000	8.83000
94.000	11.78000
96.000	15.36000
98.000	21.35000
100.000	24.87000
102.000	28.46000
104.000	30.96000
106.000	34.62000
108.000	38.04000
110.000	40.88000
112.000	42.88000
114.000	45.30000
116.000	47.74000
118.000	50.72000
120.000	53.95000
122.000	56.69000
124.000	59.26000
126.000	60.80000
128.000	62.14000
130.000	63.43000
132.000	64.71000
134.000	66.03000
136.000	67.37000
138.000	68.85000
140.000	70.45000
142.000	72.26000
144.000	74.06000
146.000	76.10000
148.000	78.48000
150.000	80.90000

EXISTING POND D

Principal Spillway Rating Curve

(Developed from Reference 3)

Paired Data | Table | Graph

Elevation (FT)	Discharge (CFS)
87.000	0.00000
142.000	0.00000
142.500	5.90000
143.000	16.60000
143.500	30.40000
144.000	43.50000
144.500	61.20000
145.000	80.20000
145.500	100.90000
146.000	123.80000
146.500	147.30000
147.000	153.30000
147.500	154.00000
148.000	154.60001

EXISTING POND E
Elevation Area Curve
(Developed from Bathymetric Survey)

Paired Data | Table | Graph

Elevation (FT)	Area (AC)
18.000	0.32000
19.000	0.89000
20.000	1.44000
21.000	2.48000
22.000	3.77000
23.000	4.59000
24.000	6.36000
25.000	7.50000
26.000	8.53000
27.000	9.36000
28.000	10.15000
29.000	10.99000
30.000	11.70000
31.000	12.31000
32.000	12.89000
33.000	13.46000
34.000	14.08000
35.000	14.84000
36.000	15.82000
37.000	18.84000
38.000	23.53000
39.000	30.14000
40.000	34.47000
42.000	35.00000
45.000	36.00000

EXISTING POND E

Principal Spillway Rating Curve

(Developed from Reference 4)

Paired Data | Table | Graph

Elevation (FT)	Discharge (CFS)
38.300	0.00000
38.500	1.72000
38.700	4.86000
38.900	8.93000
39.100	13.75000
39.300	19.22000
39.500	25.27000
39.700	31.84000
39.900	38.90000
40.100	46.42000
40.300	54.36000
40.500	62.72000
40.700	71.46000
40.900	80.58000
41.100	90.05000
41.300	99.87000
41.500	110.02000
41.700	120.50000
41.900	131.28000
42.100	142.37000
42.300	153.75999
42.500	165.42999
42.700	177.39000
42.900	191.67999
43.100	212.82001
43.300	237.89999
43.500	266.03000
43.700	296.76001
43.900	329.81000
44.100	364.95999
44.300	402.07001

REFERENCE 3
Stage Storage Curve for Pond D
Principal Spillway

TABLE VII-1

SERVICE SPILLWAY FLOWRATES

Pond Stage (elev.)	Flow rate (cfs)
142.0 (crest of weir)	0
142.5	5.9
143.0	16.6
143.5	30.4
144.0	43.5
144.5	61.2
145.0	80.2
145.5	100.9
146.0	123.8
146.5	147.3
147.0	153.3
147.5	154.0
148.0	154.6

Project Possum Point Ash Pond E (10213068)
Subject Principal Spillway Rating Curve
Date:
Filename
Source:

Schnabel
ENGINEERING

RG

Lake Level	Stage 1 Discharge Weir	Stage 2 Discharge Weir	Total Discharge	Orifice	Riser Discharge	Pipe Discharge	Pipe / Riser Discharge	Auxiliary Spillway Eff. Width	Auxiliary Spillway Discharge	Total Discharge
38.3	0.00	0.00	0 00	0.00	0 00	607.95	0.00		0.00	0.00
38.5	1.72	0.00	1.72	105.08	1.72	610.21	1.72		0.00	1.72
38.7	4.86	0.00	4 86	148 61	4 86	612.46	4.86		0.00	4.86
38.9	8.93	0.00	8 93	182 01	8.93	614.71	8.93		0.00	8.93
39.1	13.75	0.00	13 75	210.16	13.75	616.94	13.75		0.00	13.75
39.3	19.22	0.00	19.22	234.97	19.22	619.17	19.22		0.00	19.22
39.5	25.27	0.00	25 27	257.40	25 27	621.39	25.27		0.00	25.27
39.7	31.84	0.00	31.84	278.02	31.84	623.60	31.84		0.00	31.84
39.9	38.90	0.00	38.90	297.22	38.90	625.81	38.90		0.00	38.90
40.1	46.42	0.00	46.42	315.25	46.42	628.00	46.42		0.00	46.42
40.3	54.36	0.00	54.36	332.30	54.36	630.19	54.36		0.00	54 36
40.5	62.72	0.00	62.72	348.52	62.72	632.37	62.72		0.00	62.72
40.7	71.46	0.00	71.46	364.02	71.46	634.55	71.46		0.00	71 46
40.9	80.58	0 00	80.58	378.88	80.58	636.71	80.58		0.00	80.58
41.1	90.05	0 00	90.05	393.18	90.05	638.87	90.05		0 00	90.05
41.3	99.87	0.00	99.87	406.98	99.87	641.03	99 87		0.00	99.87
41.5	110.02	0 00	110.02	420.33	110.02	643.17	110.02		0.00	110.02
41.7	120.50	0.00	120.50	433.26	120.50	645.31	120.50		0.00	120.50
41.9	131.28	0.00	131.28	445.83	131 28	647.44	131.28		0 00	131.28
42.1	142.37	0.00	142.37	458.04	142.37	649.56	142.37		0.00	142.37
42.3	153 76	0.00	153.76	469.94	153.76	651 68	153.76		0.00	153.76
42.5	165.43	0.00	165.43	481.55	165.43	653.79	165.43		0.00	165.43
42.7	177.39	0 00	177 39	492.88	177 39	655 89	177.39		0.00	177.39
42.9	189.62	2.06	191.68	503.96	191.68	657.99	191.68		0.00	191.68
43.1	202 12	10.70	212.82	514.80	212 82	660 08	212.82		0 00	212.82
43.3	214.89	23.02	237.90	525.41	237.90	662.16	237.90		0.00	237.90
43.5	227.91	38.13	266 03	535.82	266 03	664.24	266.03		0.00	266.03
43.7	241.18	55.58	296.76	546.02	296.76	666 31	296.76		0.00	296.76
43.9	254.70	75.11	329.81	556.04	329.81	668 37	329.81		0.00	329.81
44 1	268.47	96.49	364.96	565.88	364.96	670.43	364.96		0.00	364.96
44 3	282.48	119.60	402.07	575 56	402.07	672.48	402.07		0.00	402.07

REFERENCE 4
Stage Storage Curve for Pond E
Principal Spillway

931

ATTACHMENT 7

HEC-HMS OUTPUT

Global Summary Results for Run "2-Year Existing"

Project: Possum Point Closures Simulation Run: 2-Year Existing

Start of Run: 30Mar2015, 00:00 Basin Model: Pond ABC Existing
End of Run: 01Apr2015, 23:00 Meteorologic Model: 2-yr Storm
Compute Time: 28Aug2015, 11:34:19 Control Specifications: Control 1

Show Elements: All Elements Volume Units: IN AC-FT Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
ABC Drainage Area	0.0570312	7.0	30Mar2015, 12:06	0.9
Quantico Creek	0.0570312	7.0	30Mar2015, 12:06	0.9

Global Summary Results for Run "10-Year Existing"

Project: Possum Point Closures Simulation Run: 10-Year Existing

Start of Run: 30Mar2015, 00:00 Basin Model: Pond ABC Existing
End of Run: 01Apr2015, 23:00 Meteorologic Model: 10-yr Storm
Compute Time: 28Aug2015, 11:35:05 Control Specifications: Control 1

Show Elements: All Elements Volume Units: IN AC-FT Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
ABC Drainage Area	0.0570312	43.3	30Mar2015, 12:03	3.1
Quantico Creek	0.0570312	43.3	30Mar2015, 12:03	3.1

Global Summary Results for Run "100-Year Existing"

Project: Possum Point Closures Simulation Run: 100-Year Existing

Start of Run: 30Mar2015, 00:00 Basin Model: Pond ABC Existing
End of Run: 01Apr2015, 23:00 Meteorologic Model: 100-yr Storm
Compute Time: 28Aug2015, 11:36:57 Control Specifications: Control 1

Show Elements: All Elements Volume Units: IN AC-FT Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
ABC Drainage Area	0.0570312	156.2	30Mar2015, 12:02	9.9
Quantico Creek	0.0570312	156.2	30Mar2015, 12:02	9.9

Global Summary Results for Run "2-Year Final"

Project: Possum Point Closures Simulation Run: 2-Year Final

Start of Run: 30Mar2015, 00:00 Basin Model: Pond ABC Final Condition
End of Run: 01Apr2015, 23:00 Meteorologic Model: 2-yr Storm
Compute Time: 28Aug2015, 11:39:33 Control Specifications: Control 1

Show Elements: All Elements Volume Units: IN AC-FT Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
Drainage Area A	0.003698	0.8	30Mar2015, 12:02	0.1
Culvert B-1	0.013207	0.7	30Mar2015, 12:07	0.1
Channel B-1	0.013207	0.7	30Mar2015, 12:07	0.1
Culvert B-2	0.003146	0.3	30Mar2015, 12:02	0.0
Channel B-2	0.003146	0.3	30Mar2015, 12:02	0.0
Basin B Direct Drainage	0.012377	2.6	30Mar2015, 12:01	0.2
Channel B-3	0.028730	3.3	30Mar2015, 12:01	0.4
B Outlet	0.032428	4.1	30Mar2015, 12:01	0.5
Junction-1	0.032428	4.1	30Mar2015, 12:01	0.5
Junction-2	0.028730	3.3	30Mar2015, 12:01	0.4
Junction-3	0.0244552	3.0	30Mar2015, 12:01	0.3
C-1 Upslope	0.009299	0.1	30Mar2015, 12:19	0.1
C-1 Direct	0.0046875	1.0	30Mar2015, 12:01	0.1
Channel C-1	0.0139865	1.0	30Mar2015, 12:01	0.1
C-2 Upslope	0.0039062	0.7	30Mar2015, 12:03	0.1
C-2 Direct	0.0065625	1.4	30Mar2015, 12:01	0.1
Channel C-2	0.0104687	2.0	30Mar2015, 12:01	0.2
Channel C-3	0.0244552	3.0	30Mar2015, 12:01	0.3
C Outlet	0.0244552	3.0	30Mar2015, 12:01	0.3

Global Summary Results for Run "10-Year Final"

Project: Possum Point Closures Simulation Run: 10-Year Final

Start of Run: 30Mar2015, 00:00 Basin Model: Pond ABC Final Condition
End of Run: 01Apr2015, 23:00 Meteorologic Model: 10-yr Storm
Compute Time: 28Aug2015, 11:41:06 Control Specifications: Control 1

Show Elements: All Elements Volume Units: IN AC-FT Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
Drainage Area A	0.003698	3.8	30Mar2015, 12:00	0.2
Culvert B-1	0.013207	7.7	30Mar2015, 12:04	0.6
Channel B-1	0.013207	7.7	30Mar2015, 12:04	0.6
Culvert B-2	0.003146	2.6	30Mar2015, 11:59	0.2
Channel B-2	0.003146	2.6	30Mar2015, 11:59	0.2
Basin B Direct Drainage	0.012377	12.9	30Mar2015, 11:58	0.7
Channel B-3	0.028730	21.3	30Mar2015, 12:00	1.5
B Outlet	0.032428	25.1	30Mar2015, 12:00	1.7
Junction-1	0.032428	25.1	30Mar2015, 12:00	1.7
Junction-2	0.028730	21.3	30Mar2015, 12:00	1.5
Junction-3	0.0244552	19.1	30Mar2015, 12:00	1.2
C-1 Upslope	0.009299	4.5	30Mar2015, 12:02	0.3
C-1 Direct	0.0046875	4.9	30Mar2015, 11:58	0.3
Channel C-1	0.0139865	8.9	30Mar2015, 12:00	0.6
C-2 Upslope	0.0039062	3.6	30Mar2015, 12:01	0.2
C-2 Direct	0.0065625	6.8	30Mar2015, 11:58	0.4
Channel C-2	0.0104687	10.3	30Mar2015, 11:59	0.6
Channel C-3	0.0244552	19.1	30Mar2015, 12:00	1.2
C Outlet	0.0244552	19.1	30Mar2015, 12:00	1.2

Global Summary Results for Run "100-Year Final"

Project: Possum Point Closures Simulation Run: 100-Year Final

Start of Run: 30Mar2015, 00:00 Basin Model: Pond ABC Final Condition
End of Run: 01Apr2015, 23:00 Meteorologic Model: 100-yr Storm
Compute Time: 28Aug2015, 11:43:14 Control Specifications: Control 1

Show Elements: All Elements Volume Units: IN AC-FT Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
Drainage Area A	0.003698	12.4	30Mar2015, 11:59	0.7
Culvert B-1	0.013207	32.0	30Mar2015, 12:03	2.1
Channel B-1	0.013207	32.0	30Mar2015, 12:03	2.1
Culvert B-2	0.003146	9.8	30Mar2015, 11:58	0.5
Channel B-2	0.003146	9.8	30Mar2015, 11:58	0.5
Basin B Direct Drainage	0.012377	43.2	30Mar2015, 11:57	2.2
Channel B-3	0.028730	79.7	30Mar2015, 11:59	4.8
B Outlet	0.032428	92.1	30Mar2015, 11:59	5.5
Junction-1	0.032428	92.1	30Mar2015, 11:59	5.5
Junction-2	0.028730	79.7	30Mar2015, 11:59	4.8
Junction-3	0.0244552	71.7	30Mar2015, 11:59	4.0
C-1 Upslope	0.009299	21.9	30Mar2015, 12:00	1.3
C-1 Direct	0.0046875	16.4	30Mar2015, 11:57	0.8
Channel C-1	0.0139865	37.3	30Mar2015, 11:59	2.1
C-2 Upslope	0.0039062	12.4	30Mar2015, 12:00	0.7
C-2 Direct	0.0065625	22.9	30Mar2015, 11:57	1.2
Channel C-2	0.0104687	34.7	30Mar2015, 11:58	1.9
Channel C-3	0.0244552	71.7	30Mar2015, 11:59	4.0
C Outlet	0.0244552	71.7	30Mar2015, 11:59	4.0

Global Summary Results for Run "25-Year E&S"

Project: Possum Point Closures Simulation Run: 25-Year E&S

Start of Run: 30Mar2015, 00:00 Basin Model: Pond ABC E&S
End of Run: 01Apr2015, 23:00 Meteorologic Model: 25-yr Storm
Compute Time: 26Aug2015, 07:39:17 Control Specifications: Control 1

Show Elements: All Elements Volume Units: IN AC-FT Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
Drainage Area A	0.003698	13.9	30Mar2015, 11:59	0.8
Culvert B-1	0.013207	15.1	30Mar2015, 12:03	1.0
Channel B-1	0.013207	15.1	30Mar2015, 12:03	1.0
Culvert B-2	0.003146	7.2	30Mar2015, 11:58	0.4
Channel B-2	0.003146	7.2	30Mar2015, 11:58	0.4
Basin B Direct	0.012377	47.5	30Mar2015, 11:57	2.5
Channel B-3	0.028730	65.0	30Mar2015, 11:58	3.9
Sed Basin B	0.032428	4.9	30Mar2015, 12:47	4.3
B Principal	0.032428	4.9	30Mar2015, 12:47	4.3
B Emergency	0.0	1.7	30Mar2015, 12:47	0.4
C-1 Upslope	0.009299	9.7	30Mar2015, 12:01	0.6
C-1 Direct	0.0046875	19.2	30Mar2015, 11:57	1.0
C-2 Upslope	0.0039062	6.4	30Mar2015, 12:00	0.4
C-2 Direct	0.0065625	26.9	30Mar2015, 11:57	1.4
Channel C-1	0.0139865	27.3	30Mar2015, 11:58	1.6
Channel C-2	0.0104687	32.4	30Mar2015, 11:57	1.8
Channel C-3	0.0244552	59.6	30Mar2015, 11:58	3.4
Sed Pond C	0.0244552	4.8	30Mar2015, 12:32	3.3
C Principal	0.0244552	4.8	30Mar2015, 12:32	3.3
C Emergency	0.0	1.1	30Mar2015, 12:32	0.1
Junction-1	0.028730	65.0	30Mar2015, 11:58	3.9
Junction-2	0.0244552	59.6	30Mar2015, 11:58	3.4

Global Summary Results for Run "25-year Final"

Project: Possum Point Closures Simulation Run: 25-year Final

Start of Run: 30Mar2015, 00:00 Basin Model: Pond ABC Final Condition
End of Run: 01Apr2015, 23:00 Meteorologic Model: 25-yr Storm
Compute Time: 26Aug2015, 07:41:48 Control Specifications: Control 1

Show Elements: All Elements Volume Units: IN (•) AC-FT Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
Drainage Area A	0.003698	6.5	30Mar2015, 12:00	0.4
Culvert B-1	0.013207	15.1	30Mar2015, 12:03	1.0
Channel B-1	0.013207	15.1	30Mar2015, 12:03	1.0
Culvert B-2	0.003146	4.8	30Mar2015, 11:58	0.3
Channel B-2	0.003146	4.8	30Mar2015, 11:58	0.3
Basin B Direct Drainage	0.012377	22.5	30Mar2015, 11:58	1.2
Channel B-3	0.028730	39.4	30Mar2015, 11:59	2.5
B Outlet	0.032428	45.8	30Mar2015, 11:59	2.9
Junction-1	0.032428	45.8	30Mar2015, 11:59	2.9
Junction-2	0.028730	39.4	30Mar2015, 11:59	2.5
Junction-3	0.0244552	35.4	30Mar2015, 11:59	2.1
C-1 Upslope	0.009299	9.7	30Mar2015, 12:01	0.6
C-1 Direct	0.0046875	8.5	30Mar2015, 11:58	0.4
Channel C-1	0.0139865	17.6	30Mar2015, 12:00	1.1
C-2 Upslope	0.0039062	6.4	30Mar2015, 12:00	0.4
C-2 Direct	0.0065625	11.9	30Mar2015, 11:58	0.6
Channel C-2	0.0104687	17.9	30Mar2015, 11:59	1.0
Channel C-3	0.0244552	35.4	30Mar2015, 11:59	2.1
C Outlet	0.0244552	35.4	30Mar2015, 11:59	2.1

Global Summary Results for Run "2-yr Storm Pre"

Project: Possum Point Closures Simulation Run: 2-yr Storm Pre

Start of Run: 30Mar2015, 00:00 Basin Model: Pond D-E Existing
End of Run: 01Apr2015, 23:00 Meteorologic Model: 2-yr Storm
Compute Time: 29Jun2015, 08:36:06 Control Specifications: Control 1

Show Elements: All Elements Volume Units: IN AC-FT Sorting: Hydrologic

Hydrologic Element	Drainage A... (MI2)	Peak Disch... (CFS)	Time of Peak	Volume (AC-FT)
Pond D Direct	0.11172	1.7	30Mar2015, 12:30	0.8
Pond D Water	0.0675460	176.7	30Mar2015, 11:56	10.4
Pond D	0.1792660	0.0	30Mar2015, 00:00	0.0
Pond E Direct Drai...	0.0578125	1.6	30Mar2015, 12:06	0.5
Pond E Water	0.045125	118.1	30Mar2015, 11:56	6.9
Metals Diversion B	0.0345312	0.1	30Mar2015, 18:04	0.1
Metals Diversion C	0.0073438	1.6	30Mar2015, 12:02	0.1
Metals Diversion A	0.0017188	0.6	30Mar2015, 12:00	0.0
Pond E	0.3257973	2.0	30Mar2015, 18:49	6.1
Outfall 005	0.3257973	2.0	30Mar2015, 18:49	6.1

Global Summary Results for Run "10-yr Storm Pre"

Project: Possum Point Closures Simulation Run: 10-yr Storm Pre

Start of Run: 30Mar2015, 00:00 Basin Model: Pond D-E Existing
End of Run: 01Apr2015, 23:00 Meteorologic Model: 10-yr Storm
Compute Time: 29Jun2015, 08:37:03 Control Specifications: Control 1

Show Elements: All Elements Volume Units: IN AC-FT Sorting: Hydrologic

Hydrologic Element	Drainage A... (MI2)	Peak Disch... (CFS)	Time of Peak	Volume (AC-FT)
Pond D Direct	0.11172	38.0	30Mar2015, 12:08	4.1
Pond D Water	0.0675460	276.3	30Mar2015, 11:56	16.6
Pond D	0.1792660	0.0	30Mar2015, 00:00	0.0
Pond E Direct Drai...	0.0578125	30.3	30Mar2015, 12:02	2.3
Pond E Water	0.045125	184.6	30Mar2015, 11:56	11.1
Metals Diversion B	0.0345312	4.4	30Mar2015, 12:09	0.7
Metals Diversion C	0.0073438	7.5	30Mar2015, 12:00	0.4
Metals Diversion A	0.0017188	2.2	30Mar2015, 11:58	0.1
Pond E	0.3257973	4.7	30Mar2015, 17:47	12.1
Outfall 005	0.3257973	4.7	30Mar2015, 17:47	12.1

Global Summary Results for Run "100-Year Pre"

Project: Possum Point Closures Simulation Run: 100-Year Pre

Start of Run: 30Mar2015, 00:00 Basin Model: Pond D-E Existing
End of Run: 01Apr2015, 23:00 Meteorologic Model: 100-yr Storm
Compute Time: 29Jun2015, 08:46:38 Control Specifications: Control 1

Show Elements: All Elements Volume Units: IN AC-FT Sorting: Hydrologic

Hydrologic Element	Drainage A... (MI2)	Peak Disch... (CFS)	Time of Peak	Volume (AC-FT)
Pond D Direct	0.11172	199.3	30Mar2015, 12:06	15.4
Pond D Water	0.0675460	478.6	30Mar2015, 11:56	29.2
Pond D	0.1792660	0.0	30Mar2015, 00:00	0.0
Pond E Direct Drai...	0.0578125	139.3	30Mar2015, 12:01	8.3
Pond E Water	0.045125	319.7	30Mar2015, 11:56	19.5
Metals Diversion B	0.0345312	45.0	30Mar2015, 12:06	3.5
Metals Diversion C	0.0073438	24.7	30Mar2015, 11:59	1.4
Metals Diversion A	0.0017188	6.6	30Mar2015, 11:57	0.3
Pond E	0.3257973	13.8	30Mar2015, 15:54	29.1
Outfall 005	0.3257973	13.8	30Mar2015, 15:54	29.1

C150132.00 Possum Point Power Station CCB Pond Closures 8/23/2015
HEC-HMS Output Summaries for Ponds D and E

Global Summary Results for Run "2-Year Post"

Project: Ponds D and E Simulation Run: 2-Year Post

Start of Run: 30Mar2015, 00:00 Basin Model: Pond D-E Post Revised
End of Run: 01Apr2015, 23:00 Meteorologic Model: 2-yr Storm
Compute Time: 23Aug2015, 10:19:48 Control Specifications: Control 1

Show Elements: All Elements Volume Units: IN AC-FT Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
Channel D-1	0.0685938	4.5	30Mar2015, 12:15	0.9
Channel D-2	0.0367188	4.2	30Mar2015, 12:10	0.6
Channel D-3	0.0495312	6.6	30Mar2015, 12:07	0.8
Channel D-4B	0.0954688	11.9	30Mar2015, 12:08	1.6
Channel D-4B Direct ...	0.0092188	1.4	30Mar2015, 12:05	0.2
Channel D-4A	0.1920782	19.1	30Mar2015, 12:09	3.0
Channel D-4A Direct ...	0.0280156	3.7	30Mar2015, 12:07	0.5
Channel E-1	0.2146110	22.3	30Mar2015, 12:07	3.5
E-1 Direct Drainage	0.0187344	5.5	30Mar2015, 12:02	0.4
Channel E-2	0.0879462	3.7	30Mar2015, 12:10	0.9
E-2 Direct Drainage	0.019813	1.6	30Mar2015, 12:10	0.3
Channel E-3	0.0373755	4.3	30Mar2015, 12:12	0.7
E-3 Direct Drainage	0.025813	3.9	30Mar2015, 12:11	0.5
Channel E-4	0.005625	0.6	30Mar2015, 12:02	0.1
Channel E-5	0.0059375	0.8	30Mar2015, 12:01	0.1
Channel E-6	0.0153122	0.8	30Mar2015, 12:03	0.1
Channel E-6 Direct Dr...	0.0135937	0.4	30Mar2015, 12:05	0.1
Metals Diversion A	0.0017185	0.6	30Mar2015, 12:00	0.0
Metals Diversion B	0.0528210	1.7	30Mar2015, 12:11	0.5
Metals Diversion C	0.0037984	0.9	30Mar2015, 12:00	0.1
outfall	0.3472717	30.7	30Mar2015, 12:08	5.2
Outlet Channel Direct	0.007339	0.9	30Mar2015, 12:12	0.1
J-1	0.0954688	11.9	30Mar2015, 12:08	1.6
J-2	0.1920782	19.1	30Mar2015, 12:09	3.0
J-3	0.2146110	22.3	30Mar2015, 12:07	3.5
J-4	0.0153122	0.8	30Mar2015, 12:03	0.1
J-5	0.0879462	3.7	30Mar2015, 12:10	0.9
J-6	0.0373755	4.3	30Mar2015, 12:12	0.7

Global Summary Results for Run "10-Year Post"

Project: Ponds D and E Simulation Run: 10-Year Post

Start of Run: 30Mar2015, 00:00 Basin Model: Pond D-E Post Revised
End of Run: 01Apr2015, 23:00 Meteorologic Model: 10-yr Storm
Compute Time: 23Aug2015, 10:19:45 Control Specifications: Control 1

Show Elements: All Elements Volume Units: IN AC-FT Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
Channel D-1	0.0685938	33.6	30Mar2015, 12:11	3.5
Channel D-2	0.0367188	24.4	30Mar2015, 12:07	2.1
Channel D-3	0.0495312	37.1	30Mar2015, 12:05	2.9
Channel D-4B	0.0954688	67.8	30Mar2015, 12:05	5.5
Channel D-4B Direct ...	0.0092188	7.8	30Mar2015, 12:03	0.5
Channel D-4A	0.1920782	117.8	30Mar2015, 12:06	10.6
Channel D-4A Direct ...	0.0280156	21.0	30Mar2015, 12:05	1.6
Channel E-1	0.2146110	133.7	30Mar2015, 12:05	12.1
E-1 Direct Drainage	0.0187344	21.9	30Mar2015, 12:00	1.3
Channel E-2	0.0879462	42.5	30Mar2015, 12:05	3.9
E-2 Direct Drainage	0.019813	11.8	30Mar2015, 12:07	1.0
Channel E-3	0.0373755	21.9	30Mar2015, 12:03	2.2
E-3 Direct Drainage	0.025813	18.4	30Mar2015, 12:09	1.7
Channel E-4	0.005625	4.7	30Mar2015, 11:59	0.3
Channel E-5	0.0059375	5.3	30Mar2015, 11:59	0.3
Channel E-6	0.0153122	9.6	30Mar2015, 12:01	0.6
Channel E-6 Direct Dr...	0.0135937	7.7	30Mar2015, 12:01	0.5
Metals Diversion A	0.0017185	2.2	30Mar2015, 11:58	0.1
Metals Diversion B	0.0528210	24.3	30Mar2015, 12:06	2.2
Metals Diversion C	0.0037984	4.2	30Mar2015, 11:58	0.2
outfall	0.3472717	202.2	30Mar2015, 12:05	18.7
Outlet Channel Direct	0.007339	4.9	30Mar2015, 12:09	0.4
J-1	0.0954688	67.8	30Mar2015, 12:05	5.5
J-2	0.1920782	117.8	30Mar2015, 12:06	10.6
J-3	0.2146110	133.7	30Mar2015, 12:05	12.1
J-4	0.0153122	9.6	30Mar2015, 12:01	0.6
J-5	0.0879462	42.5	30Mar2015, 12:05	3.9
J-6	0.0373755	21.9	30Mar2015, 12:03	2.2

Global Summary Results for Run "100-Year Post"

Project: Ponds D and E Simulation Run: 100-Year Post

Start of Run: 30Mar2015, 00:00 Basin Model: Pond D-E Post Revised
End of Run: 01Apr2015, 23:00 Meteorologic Model: 100-yr Storm
Compute Time: 23Aug2015, 10:19:47 Control Specifications: Control 1

Show Elements: All Elements Volume Units: IN AC-FT Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
Channel D-1	0.0685938	132.7	30Mar2015, 12:09	11.5
Channel D-2	0.0367188	86.9	30Mar2015, 12:06	6.6
Channel D-3	0.0495312	130.1	30Mar2015, 12:04	8.9
Channel D-4B	0.0954688	239.7	30Mar2015, 12:04	17.1
Channel D-4B Direct ...	0.0092188	26.9	30Mar2015, 12:02	1.7
Channel D-4A	0.1920782	433.0	30Mar2015, 12:05	33.7
Channel D-4A Direct ...	0.0280156	73.6	30Mar2015, 12:04	5.0
Channel E-1	0.2146110	486.3	30Mar2015, 12:04	38.1
E-1 Direct Drainage	0.0187344	67.3	30Mar2015, 11:59	3.7
Channel E-2	0.0879462	184.9	30Mar2015, 12:04	13.5
E-2 Direct Drainage	0.019813	45.6	30Mar2015, 12:05	3.3
Channel E-3	0.0373755	78.0	30Mar2015, 12:02	6.9
E-3 Direct Drainage	0.025813	61.0	30Mar2015, 12:08	5.0
Channel E-4	0.005625	17.5	30Mar2015, 11:58	0.9
Channel E-5	0.0059375	19.2	30Mar2015, 11:58	1.0
Channel E-6	0.0153122	40.7	30Mar2015, 11:59	2.3
Channel E-6 Direct Dr...	0.0135937	34.5	30Mar2015, 12:00	1.9
Metals Diversion A	0.0017185	6.6	30Mar2015, 11:57	0.3
Metals Diversion B	0.0528210	109.7	30Mar2015, 12:05	7.9
Metals Diversion C	0.0037984	13.7	30Mar2015, 11:57	0.7
outfall	0.3472717	762.6	30Mar2015, 12:04	59.8
Outlet Channel Direct	0.007339	16.7	30Mar2015, 12:08	1.4
J-1	0.0954688	239.7	30Mar2015, 12:04	17.1
J-2	0.1920782	433.0	30Mar2015, 12:05	33.7
J-3	0.2146110	486.3	30Mar2015, 12:04	38.1
J-4	0.0153122	40.7	30Mar2015, 11:59	2.3
J-5	0.0879462	184.9	30Mar2015, 12:04	13.5
J-6	0.0373755	78.0	30Mar2015, 12:02	6.9

Global Summary Results for Run "25-Year E E&S Revised"

Project: Ponds D and E Simulation Run: 25-Year E E&S Revised

Start of Run: 30Mar2015, 00:00 Basin Model: Pond E E&S Revised
End of Run: 01Apr2015, 23:00 Meteorologic Model: 25-yr Storm
Compute Time: 23Aug2015, 10:19:54 Control Specifications: Control 1

Show Elements: All Elements Volume Units: IN AC-FT Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
Channel E-1	0.0225328	72.5	30Mar2015, 11:59	4.0
E-1 Direct Drainage	0.0187344	65.3	30Mar2015, 11:59	3.6
Channel E-2	0.0879462	171.1	30Mar2015, 12:04	12.1
E-2 Direct Drainage	0.019813	52.5	30Mar2015, 12:05	3.7
Channel E-3	0.0373755	84.0	30Mar2015, 12:02	7.2
E-3 Direct Drainage	0.025813	67.4	30Mar2015, 12:07	5.4
Channel E-4	0.005625	16.7	30Mar2015, 11:57	0.9
Channel E-5	0.0059375	18.2	30Mar2015, 11:57	0.9
Channel E-6	0.0153122	19.1	30Mar2015, 12:00	1.1
Channel E-6 Direct Dr...	0.0135937	15.8	30Mar2015, 12:00	1.0
Outlet Channel Direct	0.007339	19.2	30Mar2015, 12:07	1.5
Metals Diversion A	0.0017185	3.6	30Mar2015, 11:58	0.2
Metals Diversion B	0.0528210	103.6	30Mar2015, 12:04	7.3
Metals Diversion C	0.0037984	7.3	30Mar2015, 11:58	0.4
Sed Pond E-1	0.1551935	24.5	30Mar2015, 12:39	21.3
Principal Spillway	0.1551935	24.5	30Mar2015, 12:39	21.3
Emergency Spillway	0.0	26.9	30Mar2015, 12:39	3.6
J-3	0.0225328	72.5	30Mar2015, 11:59	4.0
J-4	0.0153122	19.1	30Mar2015, 12:00	1.1
J-5	0.0879462	171.1	30Mar2015, 12:04	12.1
J-6	0.0373755	84.0	30Mar2015, 12:02	7.2

Global Summary Results for Run "25-Year DE-E&S Revised"

Project: Ponds D and E Simulation Run: 25-Year DE-E&S Revised

Start of Run: 30Mar2015, 00:00 Basin Model: Pond D-E E&S Revisesd
End of Run: 01Apr2015, 23:00 Meteorologic Model: 25-yr Storm
Compute Time: 23Aug2015, 10:19:51 Control Specifications: Control 1

Show Elements: All Elements Volume Units: IN AC-FT Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
Channel D-1	0.0685938	119.3	30Mar2015, 12:09	10.1
Channel D-2	0.0367188	102.7	30Mar2015, 12:06	7.7
Channel D-3	0.0495312	115.1	30Mar2015, 12:04	7.8
Channel D-4B	0.0954688	246.0	30Mar2015, 12:04	17.5
Channel D-4B Direct ...	0.0092188	32.1	30Mar2015, 12:01	2.0
Channel D-4A	0.1920782	440.9	30Mar2015, 12:05	33.6
Channel D-4A Direct ...	0.0280156	88.4	30Mar2015, 12:03	6.0
Channel E-1	0.2146110	472.3	30Mar2015, 12:04	36.0
E-1 Direct Drainage	0.0187344	36.4	30Mar2015, 12:00	2.0
Channel E-2	0.0879462	85.7	30Mar2015, 12:04	6.8
E-2 Direct Drainage	0.019813	22.3	30Mar2015, 12:06	1.7
Channel E-3	0.0373755	39.4	30Mar2015, 12:02	3.7
E-3 Direct Drainage	0.025813	31.9	30Mar2015, 12:08	2.7
Channel E-4	0.005625	8.7	30Mar2015, 11:58	0.5
Channel E-5	0.0059375	9.7	30Mar2015, 11:58	0.5
Channel E-6	0.0153122	19.1	30Mar2015, 12:00	1.1
Channel E-6 Direct Dr...	0.0135937	15.8	30Mar2015, 12:00	1.0
Outlet Channel Direct	0.007339	8.6	30Mar2015, 12:08	0.7
Metals Diversion A	0.0017185	3.6	30Mar2015, 11:58	0.2
Metals Diversion B	0.0528210	50.0	30Mar2015, 12:06	3.9
Metals Diversion C	0.0037984	7.3	30Mar2015, 11:58	0.4
Sed Pond E-1	0.3472717	28.2	30Mar2015, 12:28	28.5
Principal Spillway	0.3472717	28.2	30Mar2015, 12:28	28.5
Emergency Spillway	0.0	137.8	30Mar2015, 12:28	18.8
J-1	0.0954688	246.0	30Mar2015, 12:04	17.5
J-2	0.1920782	440.9	30Mar2015, 12:05	33.6
J-3	0.2146110	472.3	30Mar2015, 12:04	36.0
J-4	0.0153122	19.1	30Mar2015, 12:00	1.1
J-5	0.0879462	85.7	30Mar2015, 12:04	6.8
J-6	0.0373755	39.4	30Mar2015, 12:02	3.7

Global Summary Results for Run "25-year Post Revised"

Project: Ponds D and E Simulation Run: 25-year Post Revised

Start of Run: 30Mar2015, 00:00 Basin Model: Pond D-E Post Revised
End of Run: 01Apr2015, 23:00 Meteorologic Model: 25-yr Storm
Compute Time: 23Aug2015, 10:19:55 Control Specifications: Control 1

Show Elements: All Elements Volume Units: IN AC-FT Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
Channel D-1	0.0685938	64.1	30Mar2015, 12:10	6.0
Channel D-2	0.0367188	44.0	30Mar2015, 12:07	3.5
Channel D-3	0.0495312	66.2	30Mar2015, 12:05	4.7
Channel D-4B	0.0954688	121.9	30Mar2015, 12:05	9.1
Channel D-4B Direct ...	0.0092188	13.8	30Mar2015, 12:02	0.9
Channel D-4A	0.1920782	216.2	30Mar2015, 12:06	17.8
Channel D-4A Direct ...	0.0280156	37.4	30Mar2015, 12:05	2.7
Channel E-1	0.2146110	243.4	30Mar2015, 12:05	20.2
E-1 Direct Drainage	0.0187344	36.4	30Mar2015, 12:00	2.0
Channel E-2	0.0879462	85.7	30Mar2015, 12:04	6.8
E-2 Direct Drainage	0.019813	22.3	30Mar2015, 12:06	1.7
Channel E-3	0.0373755	39.4	30Mar2015, 12:02	3.7
E-3 Direct Drainage	0.025813	31.9	30Mar2015, 12:08	2.7
Channel E-4	0.005625	8.7	30Mar2015, 11:58	0.5
Channel E-5	0.0059375	9.7	30Mar2015, 11:58	0.5
Channel E-6	0.0153122	19.1	30Mar2015, 12:00	1.1
Channel E-6 Direct Dr...	0.0135937	15.8	30Mar2015, 12:00	1.0
Metals Diversion A	0.0017185	3.6	30Mar2015, 11:58	0.2
Metals Diversion B	0.0528210	50.0	30Mar2015, 12:06	3.9
Metals Diversion C	0.0037984	7.3	30Mar2015, 11:58	0.4
outfall	0.3472717	375.6	30Mar2015, 12:04	31.4
Outlet Channel Direct	0.007339	8.6	30Mar2015, 12:08	0.7
J-1	0.0954688	121.9	30Mar2015, 12:05	9.1
J-2	0.1920782	216.2	30Mar2015, 12:06	17.8
J-3	0.2146110	243.4	30Mar2015, 12:05	20.2
J-4	0.0153122	19.1	30Mar2015, 12:00	1.1
J-5	0.0879462	85.7	30Mar2015, 12:04	6.8
J-6	0.0373755	39.4	30Mar2015, 12:02	3.7

Global Summary Results for Run "24-HR PMF"

Project: Ponds D and E   Simulation Run: 24-HR PMF

Start of Run: 30Mar2015, 00:00   Basin Model: Pond D-E Post Revised
End of Run: 01Apr2015, 23:00   Meteorologic Model: 24 Hour PMP
Compute Time: 24Aug2015, 08:44:48   Control Specifications: Control 1

Show Elements: All Elements   Volume Units: IN ◉ AC-FT   Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
Channel D-1	0.0685938	603.0	30Mar2015, 12:22	103.4
Channel D-2	0.0367188	336.3	30Mar2015, 12:20	56.4
Channel D-3	0.0495312	462.6	30Mar2015, 12:18	76.1
Channel D-4B	0.0954688	885.2	30Mar2015, 12:18	146.6
Channel D-4B Direct ...	0.0092188	87.6	30Mar2015, 12:17	14.2
Channel D-4A	0.1920782	1744.3	30Mar2015, 12:19	293.1
Channel D-4A Direct ...	0.0280156	261.6	30Mar2015, 12:18	43.0
Channel E-1	0.2146110	1955.3	30Mar2015, 12:18	328.5
E-1 Direct Drainage	0.0187344	184.1	30Mar2015, 12:16	29.5
Channel E-2	0.0879462	796.1	30Mar2015, 12:17	129.5
E-2 Direct Drainage	0.019813	181.1	30Mar2015, 12:19	29.9
Channel E-3	0.0373755	342.3	30Mar2015, 12:16	57.7
E-3 Direct Drainage	0.025813	235.3	30Mar2015, 12:21	40.3
Channel E-4	0.005625	54.4	30Mar2015, 12:15	8.4
Channel E-5	0.0059375	57.8	30Mar2015, 12:15	8.9
Channel E-6	0.0153122	143.9	30Mar2015, 12:16	22.4
Channel E-6 Direct Dr...	0.0135937	126.8	30Mar2015, 12:16	19.7
Metals Diversion A	0.0017185	17.1	30Mar2015, 12:15	2.7
Metals Diversion B	0.0528210	475.0	30Mar2015, 12:19	77.2
Metals Diversion C	0.0037984	37.6	30Mar2015, 12:15	5.9
outfall	0.3472717	3156.2	30Mar2015, 12:17	527.0
Outlet Channel Direct	0.007339	66.5	30Mar2015, 12:21	11.4
J-1	0.0954688	885.2	30Mar2015, 12:18	146.6
J-2	0.1920782	1744.3	30Mar2015, 12:19	293.1
J-3	0.2146110	1955.3	30Mar2015, 12:18	328.5
J-4	0.0153122	143.9	30Mar2015, 12:16	22.4
J-5	0.0879462	796.1	30Mar2015, 12:17	129.5
J-6	0.0373755	342.3	30Mar2015, 12:16	57.7

Global Summary Results for Run "12-HR PMF"

Project: Ponds D and E Simulation Run: 12-HR PMF

Start of Run: 30Mar2015, 00:00 Basin Model: Pond D-E Post Revised
End of Run: 01Apr2015, 23:00 Meteorologic Model: 12 Hour PMP
Compute Time: 28Aug2015, 12:04:51 Control Specifications: Control 1

Show Elements: All Elements Volume Units: IN AC-FT Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
Channel D-1	0.0685938	590.3	30Mar2015, 06:22	89.3
Channel D-2	0.0367188	330.3	30Mar2015, 06:20	48.8
Channel D-3	0.0495312	454.8	30Mar2015, 06:18	65.8
Channel D-4B	0.0954688	869.9	30Mar2015, 06:19	126.9
Channel D-4B Direct ...	0.0092188	86.3	30Mar2015, 06:17	12.3
Channel D-4A	0.1920782	1711.2	30Mar2015, 06:19	253.4
Channel D-4A Direct ...	0.0280156	257.2	30Mar2015, 06:18	37.2
Channel E-1	0.2146110	1918.8	30Mar2015, 06:18	284.2
E-1 Direct Drainage	0.0187344	181.9	30Mar2015, 06:16	25.6
Channel E-2	0.0879462	778.6	30Mar2015, 06:17	111.5
E-2 Direct Drainage	0.019813	177.5	30Mar2015, 06:19	25.8
Channel E-3	0.0373755	336.1	30Mar2015, 06:16	50.0
E-3 Direct Drainage	0.025813	231.4	30Mar2015, 06:21	35.0
Channel E-4	0.005625	53.5	30Mar2015, 06:15	7.2
Channel E-5	0.0059375	56.9	30Mar2015, 06:15	7.7
Channel E-6	0.0153122	141.2	30Mar2015, 06:16	19.3
Channel E-6 Direct Dr...	0.0135937	124.3	30Mar2015, 06:16	16.9
Metals Diversion A	0.0017185	17.0	30Mar2015, 06:15	2.4
Metals Diversion B	0.0528210	464.5	30Mar2015, 06:19	66.5
Metals Diversion C	0.0037984	37.1	30Mar2015, 06:15	5.1
outfall	0.3472717	3093.8	30Mar2015, 06:17	455.5
Outlet Channel Direct	0.007339	65.4	30Mar2015, 06:21	9.9
J-1	0.0954688	869.9	30Mar2015, 06:19	126.9
J-2	0.1920782	1711.2	30Mar2015, 06:19	253.4
J-3	0.2146110	1918.8	30Mar2015, 06:18	284.2
J-4	0.0153122	141.2	30Mar2015, 06:16	19.3
J-5	0.0879462	778.6	30Mar2015, 06:17	111.5
J-6	0.0373755	336.1	30Mar2015, 06:16	50.0

Global Summary Results for Run "6-HR PMF"

Project: Ponds D and E Simulation Run: 6-HR PMF

Start of Run: 30Mar2015, 00:00 Basin Model: Pond D-E Post Revised
End of Run: 01Apr2015, 23:00 Meteorologic Model: 6 Hour PMP
Compute Time: 28Aug2015, 12:06:07 Control Specifications: Control 1

Show Elements: All Elements Volume Units: IN AC-FT Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
Channel D-1	0.0685938	568.0	30Mar2015, 03:23	71.6
Channel D-2	0.0367188	319.9	30Mar2015, 03:20	39.3
Channel D-3	0.0495312	441.5	30Mar2015, 03:19	53.0
Channel D-4B	0.0954688	844.0	30Mar2015, 03:19	102.1
Channel D-4B Direct ...	0.0092188	83.9	30Mar2015, 03:17	9.9
Channel D-4A	0.1920782	1653.9	30Mar2015, 03:20	203.6
Channel D-4A Direct ...	0.0280156	249.7	30Mar2015, 03:19	29.9
Channel E-1	0.2146110	1855.1	30Mar2015, 03:18	228.4
E-1 Direct Drainage	0.0187344	178.1	30Mar2015, 03:16	20.7
Channel E-2	0.0879462	749.3	30Mar2015, 03:18	89.0
E-2 Direct Drainage	0.019813	171.5	30Mar2015, 03:20	20.7
Channel E-3	0.0373755	325.2	30Mar2015, 03:16	40.2
E-3 Direct Drainage	0.025813	224.5	30Mar2015, 03:21	28.2
Channel E-4	0.005625	52.1	30Mar2015, 03:15	5.8
Channel E-5	0.0059375	55.4	30Mar2015, 03:15	6.2
Channel E-6	0.0153122	136.6	30Mar2015, 03:16	15.3
Channel E-6 Direct Dr...	0.0135937	120.0	30Mar2015, 03:16	13.4
Metals Diversion A	0.0017185	16.6	30Mar2015, 03:15	1.9
Metals Diversion B	0.0528210	446.6	30Mar2015, 03:19	53.0
Metals Diversion C	0.0037984	36.3	30Mar2015, 03:15	4.1
outfall	0.3472717	2986.9	30Mar2015, 03:18	365.5
Outlet Channel Direct	0.007339	63.3	30Mar2015, 03:21	7.9
J-1	0.0954688	844.0	30Mar2015, 03:19	102.1
J-2	0.1920782	1653.9	30Mar2015, 03:20	203.6
J-3	0.2146110	1855.1	30Mar2015, 03:18	228.4
J-4	0.0153122	136.6	30Mar2015, 03:16	15.3
J-5	0.0879462	749.3	30Mar2015, 03:18	89.0
J-6	0.0373755	325.2	30Mar2015, 03:16	40.2

APPENDIX B
Channel Design Calculations

APPENDIX B

TABLE OF CONTENTS

*Appendix sheet numbers correspond to red numbers in the upper right hand corner of each page.

SUBJECT POSSUM POINT CCR POND CLOSURES
CHANNEL DESIGN

BY SCHELAB DATE 06/28/2015 PROJ. NO. C150132.00

CHKD. BY BERKEME DATE 07/31/2015

gai consultants

INTRODUCTION:

Stormwater conveyance channels are used throughout the site to convey sediment laden water to Erosion and Sediment Controls during construction and to convey stormwater runoff to receiving waters in the post development (final) condition. This calculation utilizes flow rates developed in the Site Hydrology Calculations to size channels and select lining materials to withstand the anticipated velocities and shear stresses associated with the applicable design events.

METHODOLOGY:

Channels are designed using an iterative solution to manning's equation. Channel slopes are dictated by site grading. Channel shapes and sizes are selected to achieve the required performance. Roughness coefficients for lining products are selected using guidance from manufacturers and those provided in the VA Erosion and Sedimentation Control Handbook.

Design of ACB Channels incorporates a Factor of Safety against failure, as described in the Design Manual for Articulating Concrete Block Systems, prepared for the Harris County Flood Control District. This manual is considered by the Natural Resources Conservation Service to be the state of the art manual for ACB design.

The following design criteria have been accepted for the project:

- Channels are designed to convey the 25-year, 24-hour design storm considering both vegetated and un-vegetated conditions.
- The Pond D Outlet Channel (D-4A), which conveys flow down the existing Pond D embankment, is designed for the Probable Maximum Flood (PMF) flow.

REFERENCES

1. Virginia Erosion and Sedimentation Control Handbook, Virginia Department of Environmental Quality, 1992.
2. North American Green Erosion Control Product Literature.
3. Design Manual for Articulating Concrete Block Systems, Prepared for the Harris County Flood Control District, September 2001.

ATTACHMENTS:

1. Channel Design Worksheets
2. Channel Lining Specifications and Guidance Documents
3. ACB Factor of Safety Design Calculations

SUBJECT POSSUM POINT CCR POND CLOSURES

CHANNEL DESIGN

BY SCHELAB DATE 06/28/2015 PROJ. NO. C150132.00

CHKD. BY BERKEME DATE 07/31/2015

gai consultants

ATTACHMENT 1

CHANNEL DESIGN WORKSHEETS

CHANNEL DESIGN WORKSHEET
Channel Design Data

PROJECT NAME: Possum Point Power Station CCB Pond Closures
LOCATION: Prince William County, Virginia-Channel B1
PREPARED BY: SCHELAB DATE: 8/23/2015
CHECKED BY: PATTEJR DATE: 8/26/2015

		2.00%	2.00%	15.00%	15.00%
CHANNEL OR CHANNEL SECTION	Units	B1	B1	B1	B1
Temporary or Permanent		Permanent	Permanent	Permanent	Permanent
Design Storm		25-year	25-year	25-year	25-year
Qr (REQUIRED CAPACITY)	CFS	15	15	15	15
Q (CALCULATED AT FLOW DEPTH d)	CFS	15	15	15	15
PROTECTIVE LINING		North American Green P 550	Vegetated	North American Green P 550	Vegetated
n (MANNING'S COEFFICIENT)		0.037	0.053	0.041	0.031
Va (ALLOWABLE VELOCITY)	FPS	12.50	25.00	12.50	25.00
V (CALCULATED AT FLOW DEPTH d)	FPS	3.55	2.76	6.75	8.11
τ_a (MAX ALLOWABLE SHEAR STRESS)	LB/FT^2	4.00	14.00	4.00	14.00
τ_d (SHEAR STRESS @ FLOW DEPTH d)	LB/FT^2	0.87	1.04	3.95	3.40
CHANNEL BOTTOM WIDTH	FT	4.00	4.00	4.00	4.00
CHANNEL SIDE SLOPES (X:1)	H:V	3.00	3.00	3.00	3.00
D (TOTAL DEPTH)	FT	1.2	1.3	0.9	0.9
CHANNEL TOP WIDTH @ D	FT	11.16	12.01	9.53	9.18
d (CALCULATED FLOW DEPTH)	FT	0.69	0.84	0.42	0.36
CHANNEL TOP WIDTH @ FLOW DEPTH d	FT	8.16	9.01	6.53	6.18
d_{50} STONE SIZE	IN	N/A	N/A	N/A	N/A
A (CROSS SECTIONAL AREA)	SQ FT	4.21	5.43	2.22	1.85
R (HYDRAULIC RADIUS)		0.50	0.59	0.33	0.29
S (BED SLOPE)	FT/FT	0.020	0.020	0.150	0.150

Proposed Channel Dimensions & Linings	
Base	4.0
Required Depth	1.3
Design Depth	1.5
Z = H:V	3.0
Top Width	13.0
Lining	North American Green P 550
Lining Longevity	Permanent

CHANNEL DESIGN WORKSHEET
Channel Design Data

PROJECT NAME: Possum Point Power Station CCB Pond Closures
LOCATION: Prince William County, Virginia-Channel B2
PREPARED BY: SCHELAB DATE: 8/23/2015
CHECKED BY: PATTEJR DATE: 8/26/2015

		2.00%	2.00%	20.00%	20.00%
CHANNEL OR CHANNEL SECTION	Units	B2	B2	B2	B2
Temporary or Permanent		Permanent	Permanent	Permanent	Permanent
Design Storm		25-year	25-year	25-year	25-year
Qr (REQUIRED CAPACITY)	CFS	7	5	7	5
Q (CALCULATED AT FLOW DEPTH d)	CFS	7	5	7	5
PROTECTIVE LINING		North American Green P 550	Vegetated	North American Green P 550	Vegetated
n (MANNING'S COEFFICIENT)		0.041	0.062	0.041	0.035
Va (ALLOWABLE VELOCITY)	FPS	12.50	25.00	12.50	25.00
V (CALCULATED AT FLOW DEPTH d)	FPS	2.66	1.82	5.82	5.79
τ_s (MAX ALLOWABLE SHEAR STRESS)	LB/FT^2	4.00	14.00	4.00	14.00
τ_d (SHEAR STRESS @ FLOW DEPTH d)	LB/FT^2	0.60	0.65	3.16	2.39
CHANNEL BOTTOM WIDTH	FT	4.00	4.00	4.00	4.00
CHANNEL SIDE SLOPES (X:1)	H:V	3.00	3.00	3.00	3.00
D (TOTAL DEPTH)	FT	1.0	1.0	0.8	0.7
CHANNEL TOP WIDTH @ D	FT	9.90	10.12	8.52	8.15
d (CALCULATED FLOW DEPTH)	FT	0.48	0.52	0.25	0.19
CHANNEL TOP WIDTH @ FLOW DEPTH d	FT	6.90	7.12	5.52	5.15
d_{50} STONE SIZE	IN	N/A	N/A	N/A	N/A
A (CROSS SECTIONAL AREA)	SQ FT	2.63	2.89	1.20	0.88
R (HYDRAULIC RADIUS)		0.37	0.40	0.21	0.17
S (BED SLOPE)	FT/FT	0.020	0.020	0.200	0.200

Proposed Channel Dimensions & Linings	
Base	4.0
Required Depth	1.0
Design Depth	1.5
Z = H:V	3.0
Top Width	13.0
Lining	North American Green P 550
Lining Longevity	Permanent

CHANNEL DESIGN WORKSHEET
Channel Design Data

PROJECT NAME: Possum Point Power Station CCB Pond Closures
LOCATION: Prince William County, Virginia-Channel B3
PREPARED BY: SCHELAB DATE: 8/23/2015
CHECKED BY: PATTEJR DATE: 8/27/2015

		1.00%	1.00%	2.00%	2.00%
CHANNEL OR CHANNEL SECTION	Units	B3	B3	B3	B3
Temporary or Permanent		Permanent	Permanent	Permanent	Permanent
Design Storm		25-year	25-year	25-year	25-year
Qr (REQUIRED CAPACITY)	CFS	65	46	65	46
Q (CALCULATED AT FLOW DEPTH d)	CFS	65	46	65	46
PROTECTIVE LINING		North American Green SC 250	Vegetated	North American Green SC 250	Vegetated
n (MANNING'S COEFFICIENT)		0.026	0.056	0.028	0.045
Va (ALLOWABLE VELOCITY)	FPS	9.50	15.00	9.50	15.00
V (CALCULATED AT FLOW DEPTH d)	FPS	5.30	2.76	6.33	4.40
τ_a (MAX ALLOWABLE SHEAR STRESS)	LB/FT^2	3.00	10.00	3.00	10.00
τ_d (SHEAR STRESS @ FLOW DEPTH d)	LB/FT^2	0.78	0.97	1.38	1.54
CHANNEL BOTTOM WIDTH	FT	6.00	6.00	6.00	6.00
CHANNEL SIDE SLOPES (X:1)	H:V	3.00	3.00	3.00	2.00
D (TOTAL DEPTH)	FT	1.7	2.1	1.6	1.7
CHANNEL TOP WIDTH @ D	FT	16.50	18.36	15.62	12.94
d (CALCULATED FLOW DEPTH)	FT	1.25	1.56	1.10	1.23
CHANNEL TOP WIDTH @ FLOW DEPTH d	FT	13.50	15.36	12.62	10.94
d_{50} STONE SIZE	IN	N/A	N/A	N/A	N/A
A (CROSS SECTIONAL AREA)	SQ FT	12.19	16.67	10.27	10.45
R (HYDRAULIC RADIUS)		0.88	1.05	0.79	0.91
S (BED SLOPE)	FT/FT	0.010	0.010	0.020	0.020

Proposed Channel Dimensions & Linings	
Base	6.0
Required Depth	2.1
Design Depth	2.5
Z = H:V	3.0
Top Width	21.0
Lining	North American Green SC 250
Lining Longevity	Permanent

CHANNEL DESIGN WORKSHEET
Channel Design Data

PROJECT NAME: Possum Point Power Station CCB Pond Closures
LOCATION: Prince William County, Virginia-Channel C1
PREPARED BY: SCHELAB DATE: 8/23/2015
CHECKED BY: PATTEJR DATE: 8/26/2015

		1.00%	1.00%	8.00%	8.00%
CHANNEL OR CHANNEL SECTION	Units	C1	C1	C1 - Upslope	C1 - Upslope
Temporary or Permanent		Permanent	Permanent	Permanent	Permanent
Design Storm		25-year	25-year	25-year	25-year
Qr (REQUIRED CAPACITY)	CFS	27	18	10	10
Q (CALCULATED AT FLOW DEPTH d)	CFS	27	18	10	10
PROTECTIVE LINING		North American Green SC 250	Vegetated	North American Green SC 250	Vegetated
n (MANNING'S COEFFICIENT)[2]		0.030	0.063	0.040	0.039
Va (ALLOWABLE VELOCITY)	FPS	9.50	15.00	9.50	15.00
V (CALCULATED AT FLOW DEPTH d)	FPS	3.80	2.01	4.87	4.93
τ_a (MAX ALLOWABLE SHEAR STRESS)	LB/FT^2	3.00	10.00	3.00	10.00
τ_d (SHEAR STRESS @ FLOW DEPTH d)	LB/FT^2	0.63	0.74	1.98	1.96
CHANNEL BOTTOM WIDTH	FT	4.00	4.00	4.00	4.00
CHANNEL SIDE SLOPES (X:1)	H:V	3.00	3.00	3.00	3.00
D (TOTAL DEPTH)	FT	1.5	1.7	0.9	0.9
CHANNEL TOP WIDTH @ D	FT	13.06	14.12	9.37	9.35
d (CALCULATED FLOW DEPTH)	FT	1.01	1.19	0.40	0.39
CHANNEL TOP WIDTH @ FLOW DEPTH d	FT	10.06	11.12	6.37	6.35
d_{50} STONE SIZE	IN	N/A	N/A	N/A	N/A
A (CROSS SECTIONAL AREA)	SQ FT	7.10	8.97	2.05	2.03
R (HYDRAULIC RADIUS)		0.68	0.78	0.32	0.31
S (BED SLOPE)	FT/FT	0.010	0.010	0.080	0.080

Proposed Channel Dimensions & Linings	
Base	4.0
Required Depth	1.7
Design Depth	2.0
Z = H:V	3.0
Top Width	16.0
Lining	North American Green SC 250
Lining Longevity	Permanent

CHANNEL DESIGN WORKSHEET
Channel Design Data

PROJECT NAME: Possum Point Power Station CCB Pond Closures
LOCATION: Prince William County, Virginia-Channel C2
PREPARED BY: SCHELAB DATE: 8/23/2015
CHECKED BY: PATTEJR DATE: 8/27/2015

		1.00%	1.00%	20.00%	20.00%
CHANNEL OR CHANNEL SECTION	Units	C2	C2	C2-Upslope	C2-Upslope
Temporary or Permanent		Permanent	Permanent	Permanent	Permanent
Design Storm		25-year	25-year	25-year	25-year
Qr (REQUIRED CAPACITY)	CFS	32	18	6	6
Q (CALCULATED AT FLOW DEPTH d)	CFS	32	18	6	6
PROTECTIVE LINING[2]		North American Green SC 250	Vegetated	North American Green SC 250	Vegetated
n (MANNING'S COEFFICIENT)[2]		0.029	0.063	0.040	0.034
Va (ALLOWABLE VELOCITY)	FPS	9.50	15.00	9.50	15.00
V (CALCULATED AT FLOW DEPTH d)	FPS	4.12	2.01	5.61	6.30
τ_a (MAX ALLOWABLE SHEAR STRESS)	LB/FT^2	3.00	10.00	3.00	10.00
τ_d (SHEAR STRESS @ FLOW DEPTH d)	LB/FT^2	0.67	0.74	2.85	2.61
CHANNEL BOTTOM WIDTH	FT	4.00	4.00	4.00	4.00
CHANNEL SIDE SLOPES (X:1)	H:V	3.00	3.00	3.00	3.00
D (TOTAL DEPTH)	FT	1.6	1.7	0.7	0.7
CHANNEL TOP WIDTH @ D	FT	13.45	14.12	8.37	8.25
d (CALCULATED FLOW DEPTH)	FT	1.08	1.19	0.23	0.21
CHANNEL TOP WIDTH @ FLOW DEPTH d	FT	10.45	11.12	5.37	5.25
d_{50} STONE SIZE	IN	N/A	N/A	N/A	N/A
A (CROSS SECTIONAL AREA)	SQ FT	7.77	8.97	1.07	0.97
R (HYDRAULIC RADIUS)		0.72	0.78	0.20	0.18
S (BED SLOPE)[3]	FT/FT	0.010	0.010	0.200	0.200

Proposed Channel Dimensions & Linings	
Base	4.0
Required Depth	1.7
Design Depth	2.0
Z = H:V	3.0
Top Width	16.0
Lining	North American Green SC 250
Lining Longevity	Permanent

CHANNEL DESIGN WORKSHEET
Channel Design Data

PROJECT NAME: Possum Point Power Station CCB Pond Closures
LOCATION: Prince William County, Virginia-Channel C3
PREPARED BY: SCHELAB DATE: 8/23/2015
CHECKED BY: PATTEJR DATE: 8/26/2015

		1.00%	1.00%
CHANNEL OR CHANNEL SECTION	Units	C3	C3
Temporary or Permanent		Permanent	Permanent
Design Storm		25-year	25-year
Qr (REQUIRED CAPACITY)	CFS	35	35
Q (CALCULATED AT FLOW DEPTH d)	CFS	35	35
PROTECTIVE LINING[2]		North American Green SC 250	Vegetated
n (MANNING'S COEFFICIENT)[2]		0.031	0.058
Va (ALLOWABLE VELOCITY)	FPS	9.50	15.00
V (CALCULATED AT FLOW DEPTH d)	FPS	3.93	2.49
τ_a (MAX ALLOWABLE SHEAR STRESS)	LB/FT^2	3.00	10.00
τ_d (SHEAR STRESS @ FLOW DEPTH d)	LB/FT^2	0.62	0.86
CHANNEL BOTTOM WIDTH	FT	6.00	6.00
CHANNEL SIDE SLOPES (X:1)	H:V	3.00	3.00
D (TOTAL DEPTH)	FT	1.5	1.9
CHANNEL TOP WIDTH @ D	FT	14.95	17.31
d (CALCULATED FLOW DEPTH)	FT	0.99	1.39
CHANNEL TOP WIDTH @ FLOW DEPTH d	FT	11.95	14.31
d_{50} STONE SIZE	IN	N/A	N/A
A (CROSS SECTIONAL AREA)	SQ FT	8.91	14.07
R (HYDRAULIC RADIUS)		0.73	0.95
S (BED SLOPE)[3]	FT/FT	0.010	0.010

Proposed Channel Dimensions & Linings	
Base	6.0
Required Depth	1.9
Design Depth	2.0
Z = H:V	3.0
Top Width	18.0
Lining	North American Green SC 250
Lining Longevity	Permanent

CHANNEL DESIGN WORKSHEET
Channel Design Data

PROJECT NAME: Possum Point Power Station CCB Pond Closure
LOCATION: Prince William County, Virginia
PREPARED BY: SCHELAB DATE: 8/14/2015
CHECKED BY: PATTEJR DATE: 8/20/2015

		2.00%	2.00%
CHANNEL OR CHANNEL SECTION	Units	Channel D-1	Channel D-1
Temporary or Permanent		Permanent	Permanent
Qr (REQUIRED CAPACITY)	CFS	119.00	64.00
Q (CALCULATED AT FLOW DEPTH d)	CFS	119.00	64.00
PROTECTIVE LINING		North American Green SC 250	Vegetated
n (MANNING'S COEFFICIENT)		0.028	0.047
Va (ALLOWABLE VELOCITY)	FPS	9.50	15.00
V (CALCULATED AT FLOW DEPTH d)	FPS	6.66	3.82
τ_a (MAX ALLOWABLE SHEAR STRESS)	LB/FT^2	3.00	10.00
τ_d (SHEAR STRESS @ FLOW DEPTH d)	LB/FT^2	1.42	1.35
CHANNEL BOTTOM WIDTH	FT	10.00	10.00
CHANNEL SIDE SLOPES (X:1)	H:V	5.00	5.00
D (TOTAL DEPTH)	FT	1.64	1.59
CHANNEL TOP WIDTH @ D	FT	26.39	25.85
d (CALCULATED FLOW DEPTH)	FT	1.14	1.09
CHANNEL TOP WIDTH @ FLOW DEPTH d	FT	21.39	20.85
d_{50} STONE SIZE	IN	N/A	N/A
A (CROSS SECTIONAL AREA)	SQ FT	17.88	16.74
R (HYDRAULIC RADIUS)		0.83	0.79
S (BED SLOPE)	FT/FT	0.020	0.020

Proposed Channel Dimensions & Linings	
Base	10.0
Required Depth	1.64
Design Depth	2.0
Z = H:V	5.0
Top Width	30.0
Lining	SC 250 / Vegetated
Lining Longevity	Permanent

CHANNEL DESIGN WORKSHEET
Channel Design Data

PROJECT NAME: Possum Point Power Station CCB Pond Closure
LOCATION: Prince William County, Virginia
PREPARED BY: SCHELAB DATE: 8/14/2015
CHECKED BY: PATTEJR DATE: 8/20/2015

		2.00%	2.00%
CHANNEL OR CHANNEL SECTION	Units	Channel D-2	Channel D-2
Temporary or Permanent		Permanent	Permanent
Qr (REQUIRED CAPACITY)	CFS	103.00	44.00
Q (CALCULATED AT FLOW DEPTH d)	CFS	103.00	44.00
PROTECTIVE LINING		North American Green SC 250	Vegetated
n (MANNING'S COEFFICIENT)		0.029	0.050
Va (ALLOWABLE VELOCITY)	FPS	9.50	15.00
V (CALCULATED AT FLOW DEPTH d)	FPS	6.20	3.29
τ_a (MAX ALLOWABLE SHEAR STRESS)	LB/FT^2	3.00	10.00
τ_d (SHEAR STRESS @ FLOW DEPTH d)	LB/FT^2	1.35	1.14
CHANNEL BOTTOM WIDTH	FT	10.00	10.00
CHANNEL SIDE SLOPES (X:1)	H:V	5.00	5.00
D (TOTAL DEPTH)	FT	1.58	1.42
CHANNEL TOP WIDTH @ D	FT	25.79	24.16
d (CALCULATED FLOW DEPTH)	FT	1.08	0.92
CHANNEL TOP WIDTH @ FLOW DEPTH d	FT	20.79	19.16
d_{50} STONE SIZE	IN	N/A	N/A
A (CROSS SECTIONAL AREA)	SQ FT	16.61	13.36
R (HYDRAULIC RADIUS)		0.79	0.69
S (BED SLOPE)	FT/FT	0.020	0.020

Proposed Channel Dimensions & Linings	
Base	10.0
Required Depth	1.58
Design Depth	2.0
Z = H:V	5.0
Top Width	30.0
Lining	SC 250 / Vegetated
Lining Longevity	Permanent

CHANNEL DESIGN WORKSHEET
Channel Design Data

PROJECT NAME: Possum Point Power Station CCB Pond Closure
LOCATION: Prince William County, Virginia
PREPARED BY: SCHELAB DATE: 8/14/2015
CHECKED BY: PATTEJR DATE: 8/20/2015

		2.00%	2.00%
CHANNEL OR CHANNEL SECTION	Units	Channel D-3	Channel D-3
Temporary or Permanent		Permanent	Permanent
Qr (REQUIRED CAPACITY)	CFS	115.00	66.00
Q (CALCULATED AT FLOW DEPTH d)	CFS	115.00	66.00
PROTECTIVE LINING		North American Green SC 250	Vegetated
n (MANNING'S COEFFICIENT)		0.028	0.047
Va (ALLOWABLE VELOCITY)	FPS	9.50	15.00
V (CALCULATED AT FLOW DEPTH d)	FPS	6.56	3.87
τ_a (MAX ALLOWABLE SHEAR STRESS)	LB/FT^2	3.00	10.00
τ_d (SHEAR STRESS @ FLOW DEPTH d)	LB/FT^2	1.40	1.37
CHANNEL BOTTOM WIDTH	FT	10.00	10.00
CHANNEL SIDE SLOPES (X:1)	H:V	5.00	5.00
D (TOTAL DEPTH)	FT	1.62	1.60
CHANNEL TOP WIDTH @ D	FT	26.23	26.00
d (CALCULATED FLOW DEPTH)	FT	1.12	1.10
CHANNEL TOP WIDTH @ FLOW DEPTH d	FT	21.23	21.00
d_{50} STONE SIZE	IN	N/A	N/A
A (CROSS SECTIONAL AREA)	SQ FT	17.54	17.05
R (HYDRAULIC RADIUS)		0.82	0.80
S (BED SLOPE)	FT/FT	0.020	0.020

Proposed Channel Dimensions & Linings	
Base	10.0
Required Depth	1.62
Design Depth	2.0
Z = H:V	5.0
Top Width	30.0
Lining	SC 250 / Vegetated
Lining Longevity	Permanent

CHANNEL DESIGN WORKSHEET
Channel Design Data

PROJECT NAME: Possum Point Power Station CCB Pond Closure
LOCATION: Prince William County, Virginia
PREPARED BY: SCHELAB DATE: 8/14/2015
CHECKED BY: PATTEJR DATE: 8/20/2015

		1.50%	1.50%
CHANNEL OR CHANNEL SECTION	Units	Channel D-4B	Channel D-4B
Temporary or Permanent		Permanent	Permanent
Qr (REQUIRED CAPACITY)	CFS	246.00	122.00
Q (CALCULATED AT FLOW DEPTH d)	CFS	246.00	122.00
PROTECTIVE LINING		North American Green SC 250	Vegetated
n (MANNING'S COEFFICIENT)		0.027	0.049
Va (ALLOWABLE VELOCITY)	FPS	9.50	15.00
V (CALCULATED AT FLOW DEPTH d)	FPS	6.72	3.55
τ_a (MAX ALLOWABLE SHEAR STRESS)	LB/FT^2	3.00	10.00
τ_d (SHEAR STRESS @ FLOW DEPTH d)	LB/FT^2	1.11	1.05
CHANNEL BOTTOM WIDTH	FT	25.00	25.00
CHANNEL SIDE SLOPES (X:1)	H:V	5.00	5.00
D (TOTAL DEPTH)	FT	1.68	1.62
CHANNEL TOP WIDTH @ D	FT	41.84	41.24
d (CALCULATED FLOW DEPTH)	FT	1.18	1.12
CHANNEL TOP WIDTH @ FLOW DEPTH d	FT	36.84	36.24
d_{50} STONE SIZE	IN	N/A	N/A
A (CROSS SECTIONAL AREA)	SQ FT	36.61	34.41
R (HYDRAULIC RADIUS)		0.99	0.94
S (BED SLOPE)	FT/FT	0.015	0.015

Proposed Channel Dimensions & Linings	
Base	25.0
Required Depth	1.68
Design Depth	2.0
Z = H:V	5.0
Top Width	45.0
Lining	SC 250 / Vegetated
Lining Longevity	Permanent

CHANNEL DESIGN WORKSHEET
Channel Design Data

PROJECT NAME: Possum Point Power Station CCB Pond Closure
LOCATION: Prince William County, Virginia
PREPARED BY: SCHELAB DATE: 8/18/2015
CHECKED BY: BERKEME DATE: 8/19/2015

		3.00%	5.25%	3.00%	5.25%
CHANNEL OR CHANNEL SECTION	Units	Channel D-4A	Channel D-4A	Channel D-4A	Channel D-4A
Temporary or Permanent		Permanent	Permanent	Permanent	Permanent
Qr (REQUIRED CAPACITY)	CFS	1744.00	1744.00	1744.00	1744.00
Q (CALCULATED AT FLOW DEPTH d)	CFS	1744.00	1744.00	1744.00	1744.00
PROTECTIVE LINING		ACB Unvegetated	ACB Unvegetated	ACB Vegetated	ACB Vegetated
n (MANNING'S COEFFICIENT)		0.025	0.025	0.035	0.035
V (CALCULATED AT FLOW DEPTH d)	FPS	16.38	19.97	12.88	15.74
τ_d (SHEAR STRESS @ FLOW DEPTH d)	LB/FT^2	5.14	7.76	6.13	9.27
CHANNEL BOTTOM WIDTH	FT	25.00	25.00	25.00	25.00
CHANNEL SIDE SLOPES (X:1)	H:V	5.00	5.00	5.00	5.00
D (TOTAL DEPTH)	FT	2.75	2.37	3.27	2.83
CHANNEL TOP WIDTH @ D	FT	52.48	48.70	57.73	53.31
d (CALCULATED FLOW DEPTH)	FT	2.75	2.37	3.27	2.83
CHANNEL TOP WIDTH @ FLOW DEPTH d	FT	52.48	48.70	57.73	53.31
A (CROSS SECTIONAL AREA)	SQ FT	106.45	87.32	135.37	110.82
R (HYDRAULIC RADIUS)		2.01	1.78	2.32	2.06
S (BED SLOPE)	FT/FT	0.030	0.053	0.030	0.053

Proposed Channel Dimensions & Linings	
Base	25.0
Required Depth	3.27
Design Depth	4.0
Z = H:V	5.0
Top Width	65.0
Lining	ACB
Lining Longevity	Permanent

CHANNEL DESIGN WORKSHEET
Channel Design Data

PROJECT NAME: Possum Point Power Station CCB Pond Closures
LOCATION: Prince William County, Virginia
PREPARED BY: SCHELAB DATE: 8/17/2015
CHECKED BY: BERKEME DATE: 8/24/2015

		1.00%	1.00%	8.00%	8.00%
CHANNEL OR CHANNEL SECTION	Units	E1	E1	E1	E1
Temporary or Permanent		Permanent	Permanent	Permanent	Permanent
Design Storm		25-year	25-year	25-year	25-year
Qr (REQUIRED CAPACITY)	CFS	73	472	73	472
Q (CALCULATED AT FLOW DEPTH d)	CFS	73	472	73	472
PROTECTIVE LINING		North American Green P 550	Vegetated	North American Green P 550	Vegetated
n (MANNING'S COEFFICIENT)		0.032	0.040	0.039	0.023
Va (ALLOWABLE VELOCITY)	FPS	12.50	25.00	12.50	25.00
V (CALCULATED AT FLOW DEPTH d)	FPS	4.29	6.64	7.34	19.61
τ_a (MAX ALLOWABLE SHEAR STRESS)	LB/FT^2	4.00	14.00	4.00	14.00
τ_d (SHEAR STRESS @ FLOW DEPTH d)	LB/FT^2	0.62	2.06	3.06	6.78
CHANNEL BOTTOM WIDTH	FT	15.00	15.00	15.00	15.00
CHANNEL SIDE SLOPES (X:1)	H:V	2.00	2.00	2.00	2.00
D (TOTAL DEPTH)	FT	1.5	3.8	1.1	1.9
CHANNEL TOP WIDTH @ D	FT	21.00	30.18	19.45	22.44
d (CALCULATED FLOW DEPTH)	FT	1.00	3.29	0.61	1.36
CHANNEL TOP WIDTH @ FLOW DEPTH d	FT	19.00	28.18	17.45	20.44
d_{50} STONE SIZE	IN	N/A	N/A	N/A	N/A
A (CROSS SECTIONAL AREA)	SQ FT	17.02	71.11	9.95	24.07
R (HYDRAULIC RADIUS)		0.87	2.39	0.56	1.14
S (BED SLOPE)	FT/FT	0.010	0.010	0.080	0.080

Proposed Channel Dimensions & Linings	
Base	15.0
Required Depth	3.8
Design Depth	4.0
Z = H:V	2.0
Top Width	31.0
Lining	North American Green P 550
Lining Longevity	Permanent

CHANNEL DESIGN WORKSHEET
Channel Design Data

PROJECT NAME: Possum Point Power Station CCB Pond Closures
LOCATION: Prince William County, Virginia
PREPARED BY: SCHELAB DATE: 8/17/2015
CHECKED BY: BERKEME DATE: 8/24/2015

		1.00%	1.00%	2.00%	2.00%
CHANNEL OR CHANNEL SECTION	Units	E2	E2	E2	E2
Temporary or Permanent		Permanent	Permanent	Permanent	Permanent
Design Storm		25-year	25-year	25-year	25-year
Qr (REQUIRED CAPACITY)	CFS	171	86	171	86
Q (CALCULATED AT FLOW DEPTH d)	CFS	171	86	171	86
PROTECTIVE LINING		North American Green P 550	Vegetated	North American Green P 550	Vegetated
n (MANNING'S COEFFICIENT)		0.021	0.050	0.024	0.042
Va (ALLOWABLE VELOCITY)	FPS	12.50	25.00	12.50	25.00
V (CALCULATED AT FLOW DEPTH d)	FPS	8.16	3.58	9.40	5.15
τ_a (MAX ALLOWABLE SHEAR STRESS)	LB/FT^2	4.00	14.00	4.00	14.00
τ_d (SHEAR STRESS @ FLOW DEPTH d)	LB/FT^2	0.99	1.11	1.77	1.65
CHANNEL BOTTOM WIDTH	FT	10.00	10.00	10.00	10.00
CHANNEL SIDE SLOPES (X:1)	H:V	2.00	2.00	2.00	2.00
D (TOTAL DEPTH)	FT	2.1	2.3	1.9	1.8
CHANNEL TOP WIDTH @ D	FT	18.36	19.10	17.67	17.29
d (CALCULATED FLOW DEPTH)	FT	1.59	1.77	1.42	1.32
CHANNEL TOP WIDTH @ FLOW DEPTH d	FT	16.36	17.10	15.67	15.29
d_{50} STONE SIZE	IN	N/A	N/A	N/A	N/A
A (CROSS SECTIONAL AREA)	SQ FT	20.95	24.04	18.19	16.71
R (HYDRAULIC RADIUS)		1.22	1.34	1.11	1.05
S (BED SLOPE)	FT/FT	0.010	0.010	0.020	0.020

Proposed Channel Dimensions & Linings	
Base	10.0
Required Depth	2.3
Design Depth	2.5
Z = H:V	2.0
Top Width	20.0
Lining	North American Green P 550
Lining Longevity	Permanent

CHANNEL DESIGN WORKSHEET
Channel Design Data

PROJECT NAME: Possum Point Power Station CCB Pond Closures
LOCATION: Prince William County, Virginia
PREPARED BY: SCHELAB DATE: 10/7/2015
CHECKED BY: BERKEME DATE: 10/8/2015

		33%
CHANNEL OR CHANNEL SECTION	Units	E-2A
Temporary or Permanent		Permanent
Design Storm		25-year
Qr (REQUIRED CAPACITY)	CFS	50
Q (CALCULATED AT FLOW DEPTH d)	CFS	50
PROTECTIVE LINING		Fabricform
n (MANNING'S COEFFICIENT)		0.015
Va (ALLOWABLE VELOCITY)	FPS	N/A
V (CALCULATED AT FLOW DEPTH d)	FPS	28.34
τ_a (MAX ALLOWABLE SHEAR STRESS)	LB/FT^2	60.00
τ_d (SHEAR STRESS @ FLOW DEPTH d)	LB/FT^2	9.31
CHANNEL BOTTOM WIDTH	FT	3.00
CHANNEL SIDE SLOPES (X:1)	H:V	2.00
D (TOTAL DEPTH)	FT	1.0
CHANNEL TOP WIDTH @ D	FT	6.81
d (CALCULATED FLOW DEPTH)	*FT*	*0.45*
CHANNEL TOP WIDTH @ FLOW DEPTH d	FT	4.81
d_{50} STONE SIZE	FT	N/A
A (CROSS SECTIONAL AREA)	SQ FT	1.76
R (HYDRAULIC RADIUS)		0.35
S (BED SLOPE)	FT/FT	0.33

Proposed Channel Dimensions & Linings	
Base	3.0
Required Depth	1.0
Design Depth	1.0
Z = H:V	2.0
Top Width	7.0
Lining	Fabricform
Lining Longevity	Permanent

CHANNEL DESIGN WORKSHEET
Channel Design Data

PROJECT NAME: Possum Point Power Station CCB Pond Closures
LOCATION: Prince William County, Virginia
PREPARED BY: SCHELAB DATE: 8/17/2015
CHECKED BY: BERKEME DATE: 8/24/2015

		1.00%	1.00%
CHANNEL OR CHANNEL SECTION	Units	E3	E3
Temporary or Permanent		Permanent	Permanent
Design Storm		25-year	25-year
Qr (REQUIRED CAPACITY)	CFS	84	39
Q (CALCULATED AT FLOW DEPTH d)	CFS	84	39
PROTECTIVE LINING		North American Green SC 250	Vegetated
n (MANNING'S COEFFICIENT)		0.026	0.057
Va (ALLOWABLE VELOCITY)	FPS	9.50	15.00
V (CALCULATED AT FLOW DEPTH d)	FPS	5.57	2.57
τ_a (MAX ALLOWABLE SHEAR STRESS)	LB/FT^2	3.00	10.00
τ_d (SHEAR STRESS @ FLOW DEPTH d)	LB/FT^2	0.76	0.76
CHANNEL BOTTOM WIDTH	FT	10.00	10.00
CHANNEL SIDE SLOPES (X:1)	H:V	2.00	2.00
D (TOTAL DEPTH)	FT	1.7	1.7
CHANNEL TOP WIDTH @ D	FT	16.85	16.88
d (CALCULATED FLOW DEPTH)	FT	1.21	1.22
CHANNEL TOP WIDTH @ FLOW DEPTH d	FT	14.85	14.88
d_{50} STONE SIZE	IN	N/A	N/A
A (CROSS SECTIONAL AREA)	SQ FT	15.08	15.18
R (HYDRAULIC RADIUS)		0.98	0.98
S (BED SLOPE)	FT/FT	0.010	0.010

Proposed Channel Dimensions & Linings	
Base	10.0
Required Depth	1.7
Design Depth	2.0
Z = H:V	2.0
Top Width	18.0
Lining	North American Green SC 250
Lining Longevity	Permanent

CHANNEL DESIGN WORKSHEET
Channel Design Data

PROJECT NAME: Possum Point Power Station CCB Pond Closures
LOCATION: Prince William County, Virginia
PREPARED BY: SCHELAB DATE: 8/23/2015
CHECKED BY: PATTEJR DATE: 8/28/2015

		2%	2%	5%	5%
CHANNEL OR CHANNEL SECTION	Units	E4	E4	E4 (Steep Section)	E4 (Steep Section)
Temporary or Permanent		Permanent	Permanent	Permanent	Permanent
Design Storm		25-year	25-year	25-year	25-year
Qr (REQUIRED CAPACITY)	CFS	17	9	17	9
Q (CALCULATED AT FLOW DEPTH d)	CFS	17	9	17	9
PROTECTIVE LINING		North American Green P 550	Vegetated	North American Green P 550	Vegetated
n (MANNING'S COEFFICIENT)		0.041	0.062	0.041	0.050
Va (ALLOWABLE VELOCITY)	FPS	12.50	25.00	12.50	25.00
V (CALCULATED AT FLOW DEPTH d)	FPS	3.04	1.86	4.07	2.85
τ_a (MAX ALLOWABLE SHEAR STRESS)	LB/FT^2	4.00	14.00	4.00	14.00
τ_d (SHEAR STRESS @ FLOW DEPTH d)	LB/FT^2	0.63	0.56	1.21	0.93
CHANNEL BOTTOM WIDTH	FT	10.00	10.00	10.00	10.00
CHANNEL SIDE SLOPES (X:1)	H:V	2.00	2.00	2.00	2.00
D (TOTAL DEPTH)	FT	1.0	0.9	0.9	0.8
CHANNEL TOP WIDTH @ D	FT	14.03	13.78	13.55	13.19
d (CALCULATED FLOW DEPTH)	*FT*	*0.51*	*0.44*	*0.39*	*0.30*
CHANNEL TOP WIDTH @ FLOW DEPTH d	FT	12.03	11.78	11.55	11.19
d_{50} STONE SIZE	IN	N/A	N/A	N/A	N/A
A (CROSS SECTIONAL AREA)	SQ FT	5.60	4.84	4.18	3.16
R (HYDRAULIC RADIUS)		0.46	0.40	0.36	0.28
S (BED SLOPE)	FT/FT	0.020	0.020	0.050	0.050

Proposed Channel Dimensions & Linings	
Base	10.0
Required Depth	1.0
Design Depth	1.0
Z = H:V	2.0
Top Width	14.0
Lining	North American Green P 550
Lining Longevity	Permanent

CHANNEL DESIGN WORKSHEET
Channel Design Data

PROJECT NAME: Possum Point Power Station CCB Pond Closures
LOCATION: Prince William County, Virginia
PREPARED BY: BERKEME DATE: 10/7/2015
CHECKED BY: SCHELAB DATE: 10/13/2015

		22.00%	22%
CHANNEL OR CHANNEL SECTION	Units	E-4A	E-4A
Temporary or Permanent		Permanent	Permanent
Design Storm	INCHES	25-year	25-year
Qr (REQUIRED CAPACITY)	CFS	17.00	9
Q (CALCULATED AT FLOW DEPTH d)	CFS	17.00	9
PROTECTIVE LINING		NA GREEN P550	Vegetated
n (MANNING'S COEFFICIENT)		0.017	0.041
Va (ALLOWABLE VELOCITY)	FPS	12.50	25.00
V (CALCULATED AT FLOW DEPTH d)	FPS	11.08	3.81
τ_a (MAX ALLOWABLE SHEAR STRESS)	LB/FT^2	4.00	14.00
τ_d (SHEAR STRESS @ FLOW DEPTH d)	LB/FT^2	2.02	1.49
CHANNEL BOTTOM WIDTH	FT	10.00	10.00
CHANNEL SIDE SLOPES (X:1)	H:V	3.00	3.00
D (TOTAL DEPTH)	FT	0.65	0.11
CHANNEL TOP WIDTH @ D	FT	13.88	10.65
d (CALCULATED FLOW DEPTH)	FT	0.15	0.11
CHANNEL TOP WIDTH @ FLOW DEPTH d	FT	10.88	10.65
A (CROSS SECTIONAL AREA)	SQ FT	1.53	1.12
R (HYDRAULIC RADIUS)		0.14	0.10
S (BED SLOPE)	FT/FT	0.220	0.220

Proposed Channel Dimensions & Linings	
Base	10.0
Required Depth	0.1
Design Depth	0.5
Z = H:V	3.0
Top Width	13.0
Lining	NA GREEN P550
Lining Longevity	Permanent

CHANNEL DESIGN WORKSHEET
Channel Design Data

PROJECT NAME: Possum Point Power Station CCB Pond Closures
LOCATION: Prince William County, Virginia
PREPARED BY: SCHELAB DATE: 8/23/2015
CHECKED BY: PATTEJR DATE: 8/28/2015

		2%	2%	5%	5%
CHANNEL OR CHANNEL SECTION	Units	E5	E5	E5	E5
Temporary or Permanent		Permanent	Permanent	Permanent	Permanent
Design Storm		25-year	25-year	25-year	25-year
Qr (REQUIRED CAPACITY)	CFS	18	10	18	10
Q (CALCULATED AT FLOW DEPTH d)	CFS	18	10	18	10
PROTECTIVE LINING		North American Green SC 250	Vegetated	North American Green SC 250	Vegetated
n (MANNING'S COEFFICIENT)		0.040	0.061	0.040	0.049
Va (ALLOWABLE VELOCITY)	FPS	9.50	15.00	9.50	15.00
V (CALCULATED AT FLOW DEPTH d)	FPS	3.16	1.95	4.22	3.00
τ_a (MAX ALLOWABLE SHEAR STRESS)	LB/FT^2	3.00	10.00	3.00	10.00
τ_d (SHEAR STRESS @ FLOW DEPTH d)	LB/FT^2	0.64	0.58	1.23	0.98
CHANNEL BOTTOM WIDTH	FT	10.00	10.00	10.00	10.00
CHANNEL SIDE SLOPES (X:1)	H:V	2.00	2.00	2.00	2.00
D (TOTAL DEPTH)	FT	1.0	1.0	0.9	0.8
CHANNEL TOP WIDTH @ D	FT	14.07	13.87	13.58	13.25
d (CALCULATED FLOW DEPTH)	*FT*	*0.52*	*0.47*	*0.40*	*0.31*
CHANNEL TOP WIDTH @ FLOW DEPTH d	FT	12.07	11.87	11.58	11.25
d_{50} STONE SIZE	IN	N/A	N/A	N/A	N/A
A (CROSS SECTIONAL AREA)	SQ FT	5.70	5.12	4.26	3.33
R (HYDRAULIC RADIUS)		0.46	0.42	0.36	0.29
S (BED SLOPE)	FT/FT	0.020	0.020	0.050	0.050

Proposed Channel Dimensions & Linings	
Base	10.0
Required Depth	1.0
Design Depth	1.0
Z = H:V	2.0
Top Width	14.0
Lining	North American Green SC 250
Lining Longevity	Permanent

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CHANNEL DESIGN WORKSHEET
Channel Design Data

PROJECT NAME: Possum Point Power Station CCB Pond Closures
LOCATION: Prince William County, Virginia
PREPARED BY: BERKEME DATE: 10/7/2015
CHECKED BY: SCHELAB DATE: 10/13/2015

		10.00%	10%
CHANNEL OR CHANNEL SECTION	Units	E-5A	E-5A
Temporary or Permanent		Permanent	Permanent
Design Storm	INCHES	25-year	25-year
Qr (REQUIRED CAPACITY)	CFS	18.00	10
Q (CALCULATED AT FLOW DEPTH d)	CFS	18.00	10
PROTECTIVE LINING		NA GREEN SC250	Vegetated
n (MANNING'S COEFFICIENT)		0.029	0.045
Va (ALLOWABLE VELOCITY)	FPS	9.50	15.00
V (CALCULATED AT FLOW DEPTH d)	FPS	6.33	3.35
τ_a (MAX ALLOWABLE SHEAR STRESS)	LB/FT^2	3.00	10.00
τ_d (SHEAR STRESS @ FLOW DEPTH d)	LB/FT^2	1.65	1.19
CHANNEL BOTTOM WIDTH	FT	10.00	10.00
CHANNEL SIDE SLOPES (X:1)	H:V	3.00	3.00
D (TOTAL DEPTH)	FT	0.76	0.19
CHANNEL TOP WIDTH @ D	FT	14.58	11.15
d (CALCULATED FLOW DEPTH)	FT	0.26	0.19
CHANNEL TOP WIDTH @ FLOW DEPTH d	FT	11.58	11.15
A (CROSS SECTIONAL AREA)	SQ FT	2.85	2.02
R (HYDRAULIC RADIUS)		0.24	0.18
S (BED SLOPE)	FT/FT	0.100	0.100

Proposed Channel Dimensions & Linings	
Base	10.0
Required Depth	0.3
Design Depth	0.5
Z = H:V	3.0
Top Width	13.0
Lining	NA GREEN SC250
Lining Longevity	Permanent

CHANNEL DESIGN WORKSHEET
Channel Design Data

PROJECT NAME: Possum Point Power Station CCB Pond Closures
LOCATION: Prince William County, Virginia
PREPARED BY: SCHELAB DATE: 8/23/2015
CHECKED BY: PATTEJR DATE: 8/28/2015

		0.70%	0.70%	3.50%	3.50%
CHANNEL OR CHANNEL SECTION	Units	E6 (Flat Section)	E6 (Flat Section)	E6 (Steep Section)	E6 (Steep Section)
Temporary or Permanent		Permanent	Permanent	Permanent	Permanent
Design Storm		25-year	25-year	25-year	25-year
Qr (REQUIRED CAPACITY)	CFS	19	19	19	19
Q (CALCULATED AT FLOW DEPTH d)	CFS	19	19	19	19
PROTECTIVE LINING		North American Green SC 250	Vegetated	North American Green SC 250	Vegetated
n (MANNING'S COEFFICIENT)		0.037	0.070	0.040	0.047
Va (ALLOWABLE VELOCITY)	FPS	9.50	15.00	9.50	15.00
V (CALCULATED AT FLOW DEPTH d)	FPS	2.42	1.57	3.84	3.45
τ_a (MAX ALLOWABLE SHEAR STRESS)	LB/FT^2	3.00	10.00	3.00	10.00
τ_d (SHEAR STRESS @ FLOW DEPTH d)	LB/FT^2	0.30	0.44	0.99	1.09
CHANNEL BOTTOM WIDTH	FT	10.00	10.00	10.00	10.00
CHANNEL SIDE SLOPES (X:1)	H:V	2.00	2.00	2.00	2.00
D (TOTAL DEPTH)	FT	1.2	1.5	1.0	1.0
CHANNEL TOP WIDTH @ D	FT	14.76	16.03	13.81	14.00
d (CALCULATED FLOW DEPTH)	*FT*	*0.69*	*1.01*	*0.45*	*0.50*
CHANNEL TOP WIDTH @ FLOW DEPTH d	FT	12.76	14.03	11.81	12.00
d_{50} STONE SIZE	IN	N/A	N/A	N/A	N/A
A (CROSS SECTIONAL AREA)	SQ FT	7.85	12.12	4.94	5.51
R (HYDRAULIC RADIUS)		0.60	0.84	0.41	0.45
S (BED SLOPE)	FT/FT	0.007	0.007	0.035	0.035

Proposed Channel Dimensions & Linings	
Base	10.0
Required Depth	1.5
Design Depth	1.5
Z = H:V	2.0
Top Width	16.0
Lining	North American Green SC 250
Lining Longevity	Permanent

CHANNEL DESIGN WORKSHEET
Channel Design Data

PROJECT NAME: Possum Point Power Station CCB Pond Closures
LOCATION: Prince William County, Virginia
PREPARED BY: BERKEME DATE: 10/7/2015
CHECKED BY: SCHELAB DATE: 10/13/2105

		8.30%	8.30%
CHANNEL OR CHANNEL SECTION	Units	E-6A	E-6A
Temporary or Permanent		Permanent	Permanent
Design Storm	INCHES	25-year	25-year
Qr (REQUIRED CAPACITY)	CFS	21.00	21
Q (CALCULATED AT FLOW DEPTH d)	CFS	21.00	21
PROTECTIVE LINING		NA GREEN SC250	Vegetated
n (MANNING'S COEFFICIENT)		0.029	0.038
Va (ALLOWABLE VELOCITY)	FPS	9.50	15.00
V (CALCULATED AT FLOW DEPTH d)	FPS	6.31	5.24
τ_a (MAX ALLOWABLE SHEAR STRESS)	LB/FT^2	3.00	10.00
τ_d (SHEAR STRESS @ FLOW DEPTH d)	LB/FT^2	1.58	1.84
CHANNEL BOTTOM WIDTH	FT	10.00	10.00
CHANNEL SIDE SLOPES (X:1)	H:V	3.00	3.00
D (TOTAL DEPTH)	FT	0.81	0.36
CHANNEL TOP WIDTH @ D	FT	14.83	12.14
d (CALCULATED FLOW DEPTH)	FT	0.31	0.36
CHANNEL TOP WIDTH @ FLOW DEPTH d	FT	11.83	12.14
A (CROSS SECTIONAL AREA)	SQ FT	3.33	3.94
R (HYDRAULIC RADIUS)		0.28	0.32
S (BED SLOPE)	FT/FT	0.083	0.083

Proposed Channel Dimensions & Linings	
Base	10.0
Required Depth	0.3
Design Depth	0.5
Z = H:V	3.0
Top Width	13.0
Lining	NA GREEN SC250
Lining Longevity	Permanent

CHANNEL DESIGN WORKSHEET
Channel Design Data

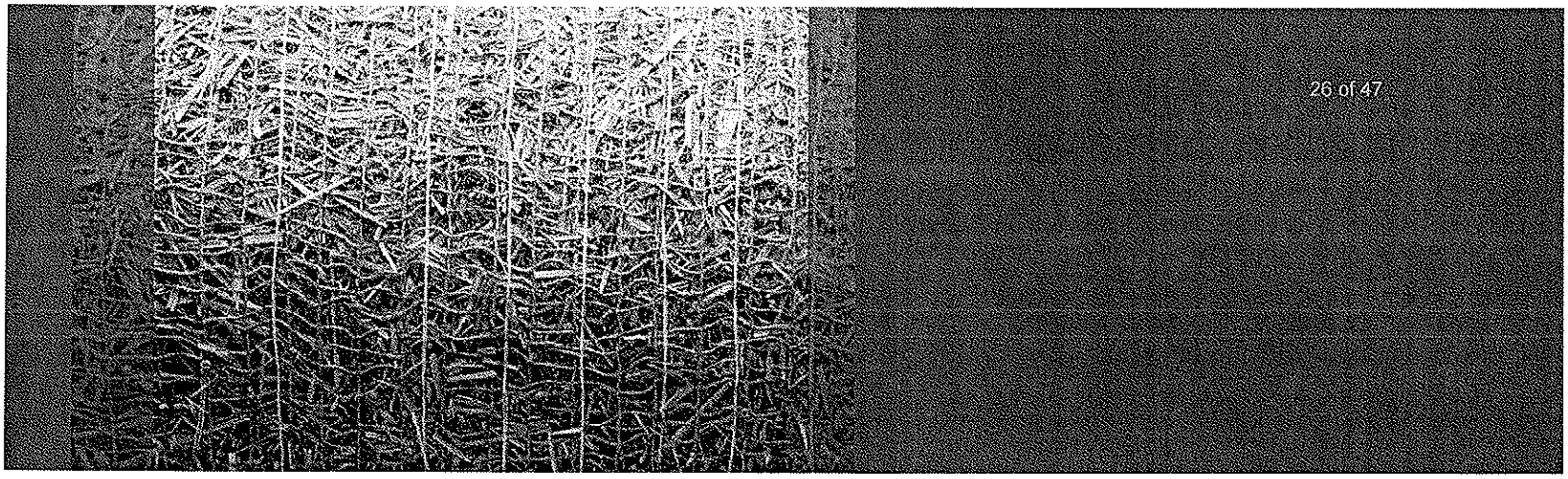
PROJECT NAME: Possum Point Power Station CCB Pond Closures
LOCATION: Prince William County, Virginia
PREPARED BY: SCHELAB DATE: 8/17/2015
CHECKED BY: PATTEJR DATE: 8/28/2015

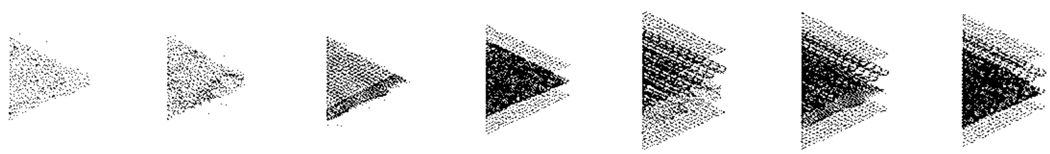
		1.00%	1.00%
CHANNEL OR CHANNEL SECTION	**Units**	**Outlet Channel**	**Outlet Channel**
Temporary or Permanent		**Permanent**	**Permanent**
Design Storm		**25-year**	**25-year**
Qr (REQUIRED CAPACITY)	**CFS**	**376**	**376**
Q (CALCULATED AT FLOW DEPTH d)	**CFS**	**376**	**376**
PROTECTIVE LINING		**North American Green P 550**	**Vegetated**
n (MANNING'S COEFFICIENT)		**0.017**	**0.041**
Va (ALLOWABLE VELOCITY)	**FPS**	**12.50**	**25.00**
V (CALCULATED AT FLOW DEPTH d)	**FPS**	**11.25**	**6.06**
τ_a (MAX ALLOWABLE SHEAR STRESS)	**LB/FT^2**	**4.00**	**14.00**
τ_d (SHEAR STRESS @ FLOW DEPTH d)	**LB/FT^2**	**1.12**	**1.85**
CHANNEL BOTTOM WIDTH	**FT**	**15.00**	**15.00**
CHANNEL SIDE SLOPES (X:1)	**H:V**	**2.00**	**2.00**
D (TOTAL DEPTH)	**FT**	**2.3**	**3.5**
CHANNEL TOP WIDTH @ D	**FT**	**24.19**	**28.86**
d (CALCULATED FLOW DEPTH)	**FT**	**1.80**	**2.97**
CHANNEL TOP WIDTH @ FLOW DEPTH d	**FT**	**22.19**	**26.86**
d_{50} STONE SIZE	**IN**	**N/A**	**N/A**
A (CROSS SECTIONAL AREA)	**SQ FT**	**33.41**	**62.06**
R (HYDRAULIC RADIUS)		**1.45**	**2.20**
S (BED SLOPE)	**FT/FT**	**0.010**	**0.010**
S_c (CRITICAL SLOPE)	**FT/FT**	**0.00**	**0.02**

Proposed Channel Dimensions & Linings	
Base	**15.0**
Required Depth	**3.5**
Design Depth	**3.5**
Z = H:V	**2.0**
Top Width	**29.0**
Lining	**North American Green P 550**
Lining Longevity	**Permanent**

ATTACHMENT 2

CHANNEL LINING SPECIFICATIONS





	TEMPORARY			PERMANENT			
	BIONET			ERONET	VMAX		
	S150BN	SC150BN	C125BN	P300	SC250	C350	P550
Longevity	12 mo.	18 mo.	24 mo.	Permanent	Permanent	Permanent	Permanent
Applications	Moderate Flow Channels 3:1-2:1 Slopes	Medium Flow Channels 2:1-1:1 Slopes	High-Flow Channels 1:1 and Greater Slopes	High-Flow Channels 1:1 Slopes	High-Flow Channels 1:1 and Greater Slopes	High-Flow Channels 1:1 and Greater Slopes	Extreme High-Flow Channels 1:1 and Greater Slopes
Design Permissible Shear Stress lbs/ft² (Pa)	Unvegetated 1.85 (88)	Unvegetated 2.10 (100)	Unvegetated 2.35 (112)	Unvegetated 3.0 (144) Vegetated 8.0 (383)	Unvegetated 3.0 (144) Vegetated 10.0 (480)	Unvegetated 3.2 (153) Vegetated 12.0 (576)	Unvegetated 4.0 (191) Vegetated 14.0 (672)
Design Permissible Velocity ft/s (m/s)	Unvegetated 6.00 (1.83)	Unvegetated 8.00 (2.44)	Unvegetated 10.00 (3.05)	Unvegetated 9.00 (2.7) Vegetated 16.0 (4.9)	Unvegetated 9.5 (2.9) Vegetated 15.0 (4.6)	Unvegetated 10.5 (3.2) Vegetated 20.0 (6.0)	Unvegetated 12.5 (3.8) Vegetated 25.0 (7.6)
Top Net	Leno woven, 100% biodegradable jute fiber 9.30 lbs/1000 ft² (4.53 kg/100 m²) approx wt	Leno woven, 100% biodegradable jute fiber 9.30 lbs/1000 ft² (4.53 kg/100 m²) approx wt	Leno woven, 100% biodegradable jute fiber 9.30 lbs/1000 ft² (4.53 kg/100 m²) approx wt	Heavyweight UV-stabilized polypropylene 5.0 lbs/1000 ft² (2.44 kg/100 m²) approx wt	Heavyweight polypropylene 5.0 lbs/1000 ft² (2.44 kg/100 m²) approx wt	Extra heavyweight polypropylene 8.0 lbs/1000 ft² (3.91 kg/100 m²) approx wt	Ultra heavyweight polypropylene 24.0 lbs/1000 ft² (11.7 kg/100 m²) approx wt
Center Net	N/A	N/A	N/A	N/A	Ultra heavyweight polypropylene – corrugated 24.0 lbs/1000 ft² (11.7 kg/100 m²)	Ultra heavyweight polypropylene – corrugated 24.0 lbs/1000 ft² (11.7 kg/100 m²)	Ultra heavyweight polypropylene – corrugated 24.0 lbs/1000 ft² (11.7 kg/100 m²)
Fiber Matrix	Straw fiber 0.50 lbs/yd² (0.27 kg/m²)	Straw/coconut matrix 70% Straw 0.35 lbs/yd² (0.19 kg/m²) 30% Coconut 0.15 lbs/yd² (0.08 kg/m²)	Coconut fiber 0.50 lbs/yd² (0.27 kg/m²)	UV-stabilized polypropylene fiber 0.70 lbs/yd² (0.38 kg/m²)	Straw/coconut matrix 70% Straw 0.35 lbs/yd² (0.19 kg/m²) 30% Coconut 0.15 lbs/yd² (0.08 kg/m²)	Coconut fiber 0.50 lbs/yd² (0.27 kg/m²)	UV-stabilized polypropylene fiber 0.50 lbs/yd² (0.27 kg/m²)
Bottom Net	Woven, 100% biodegradable jute fiber 7.70 lbs/1000 ft² (3.76 kg/100 m²) approx wt	Woven, 100% biodegradable jute fiber 7.70 lbs/1000 ft² (3.76 kg/100 m²) approx wt	Woven, 100% biodegradable jute fiber 7.70 lbs/1000 ft² (3.76 kg/100 m²) approx wt	Heavyweight UV-stabilized polypropylene 3.0 lbs/1000 ft² (1.47 kg/100 m²) approx wt	Heavyweight UV-stabilized polypropylene 5.0 lbs/1000 ft² (2.44 kg/100 m²) approx wt	Extra heavyweight polypropylene 8.0 lbs/1000 ft² (3.91 kg/100 m²) approx wt	Ultra heavyweight polypropylene 24.0 lbs/1000 ft² (11.7 kg/100 m²) approx wt
Thread	Biodegradable	Biodegradable	Biodegradable	UV-stabilized polypropylene	UV-stabilized polypropylene	UV-stabilized polypropylene fiber	UV-stabilized polypropylene

It is good practice to use a higher "n" value within the range of a lining material in order to achieve a conservative design. It is usually unacceptable to use the lowest value since some minor imperfections in the channel lining are likely and the lining will become somewhat less hydraulically efficient over time.

Rigid Channel Linings

Table 5-12 lists the Mannings "n" values for many of the commonly used channel linings.

Flexible Channel Linings

Riprap:

The Manning "n" value varies with mean stone size, as follows: N-Value for Rock Lined Channels

$$n = 0.0395\ (d_{50})^{1/6}$$

where,

d_{50} = the median size (feet) of the stone riprap.

Thus, the following "n" values apply for common stone sizes:

d_{50} (ft.)	n
0.25	0.0314
0.50	0.0352
0.75	0.0377
1.00	0.0395
1.50	0.0423

Vegetative Linings:

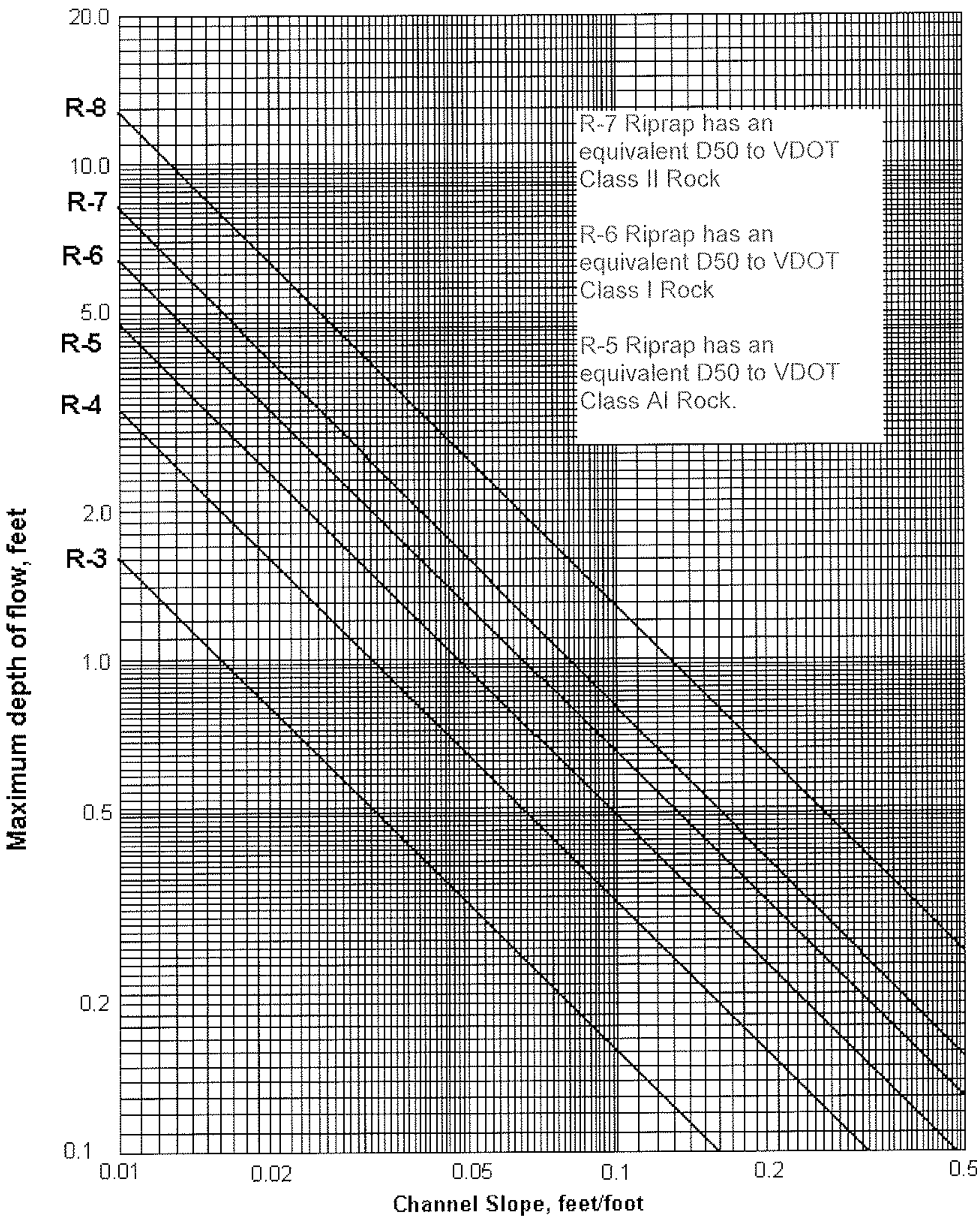
Manning "n" values vary with hydraulic radius, velocity, as well as roughness. While usually not considered important for moderate size rigid-lined channels, the effect of velocity on Manning "n" values is considered especially significant when related to vegetative linings. Accordingly, curves have been developed to represent the interaction between hydraulic radius, velocity and roughness coefficient as related to various vegetative retardances. (See Plate 5-29 and Table 5-13.)

For grass-lined channels, Mannings "n" value can be determined by the following procedure:

1. Determine the maximum permissible velocity (V) for the grass to be used. (See Table 5-14 and Plate 5-30.)

2. Calculate the hydraulic radius (R) of the channel. (See Plate 5-28.)

FIGURE 6.1
Maximum Permissible Flow Depth for Riprap Channels



MAXIMUM DEPTH OF FLOW FOR RIPRAP LINED CHANNELS

Adapted from VDH&T Drainage Manual

TABLE 6.6
Riprap Gradation, Filter Blanket Requirements, Maximum Velocities

	Percent Passing (Square Openings)					
Class, Size NO. / Rock Size (Inches)	R-8	R-7	R-6	R-5	R-4	R-3
42	100					
30		100				
24	15-50		100			
18		15-50		100		
15	0-15					
12		0-15	15-50		100	
9				15-50		
6			0-15		15-50	100
4				0-15		
3					0-15	15-50
2						0-15
Nominal Placement Thickness (inches)	63	45	36	27	18	9
Filter Stone[1]	AASHTO #1	AASHTO #1	AASHTO #1	AASHTO #3	AASHTO #3	AASHTO #57
V_{max} (ft/sec)	17.0	14.5	13.0	11.5	9.0	6.5

Adapted from PennDOT Pub. 408, Section 703.2(c), Table C

R-7 Riprap has an equivalent D50 to VDOT Class II Rock

1 This is a general standard. Soil cor nalyzed to determine actual filter size. A suitable woven or non-wove d according to the manufacturer's recommendations, r stone for gradients < 10%.

R-6 Riprap has an equivalent D50 to VDOT Class I Rock

Comparison of Va Aggregates

R-5 Riprap has an equivalent D50 to VDOT Class AI Rock.

AASHTO NUMBER	6 ½	4"	3 ½"	2 ½	2"					3/8"	#4	#8	#16	#30	#100
1		100	90-100	25-60											
3				100	90-100	35-70	0-15		0-5						
5						100	90-100	20-55	0-10	0-5					
57						100	90-100		25-60		0-10	0-5			
67							100	90-100		20-55	0-10	0-5			
7								100	90-100	40-70	0-15	0-5			
8									100	85-100	10-30	0-10	0-5		
10										100	75-100				10-30

PennDOT Publication 408, Section 703.2(c), Table C

Tables 6.6 and 6.7 should be placed on the plan drawings of all sites where riprap channel linings are proposed.

ATTACHMENT 3

ACB Factor of Safety Design Calculation

Project:	By:	Date:
Possum Point	SCHELAB	8/18/2015
Pond D	Checked:	Date:
Location:	BERKEME	8/19/2015
Channel D-4A		

gai consultants

ACB information provided by manufacturer and Jim Nadeau of ACF Environmental

BLOCK	Height (in)	Width (in)	Length (in)					
SD-475 OCT	4.75	15.5	17.4					
BLOCK	l_1	l_2	l_3	l_4	G	*Wb*	*Ws*	τ_c
SD-475 OCT	0.198	0.971	0.317	0.971	2.2	65	35	25.9

Allowable Block Protrusion: 0 in *tapered blocks to be used*

Select Block: **SD-475 OCT**

Moment Arms:

L1	0.198
L2	0.971
L3	0.317
L4	0.971

$\ell_1 = \frac{1}{2} \times \text{block thickness}$

$\ell_2 = \ell_4 = \sqrt{(\text{block length})^2 + (\text{block width})^2}$ x 0.5 *equation correction*

$\ell_3 = 0.8 \times \text{block thickness}$

Submerged Unit Wt. of Block:

Ws= 35.00 *assume 140 pcf for concrete*

Gc = 140/62.4 = *2.20*

$$W_S = W \times \left(\frac{G_c - 1}{G_c}\right)$$

Predicted Shear Stress from Mannings Equation Solution

Unvegetated	t(des):	7.96
Vegetated	t(des):	9.54

Predicted Velocity from Mannings Equation Solution

Unvegetated	V(des):	20.69
Vegetated	V(des):	16.34

Block Critical Shear Stress

t(c): 25.9

Stability Number on Horizontal Surface:

Unvegetated	η_0=	0.307
Vegetated	η_0=	0.368

$$\eta_0 = \frac{\tau_{des}}{\tau_c}$$

Project:	By:	Date:
Possum Point	SCHELAB	8/18/2015
Pond D	Checked:	Date:
Location:	BERKEME	8/19/2015
Channel D-4A		

gai consultants

Lift and Drag Forces from Block Protrusion:

$F'_d = .5 \times C_d(\Delta Z)b\rho V^2$

Cd = 1 *approximate as a cylinder, Table 5.1, p. 281 in FLUID MECHANICS, 6th ed, Streeter, V.L. & Wylie, E.B., Mc-Graw Hill Book Company, New York, 1975*

$$F'_D = \frac{1}{2} \times C_D(\Delta Z)b\rho V^2 \quad \text{(eq. TS14L-2)}$$

where:
F'_D = drag force due to block protrusion (lb)
C_D = drag coefficient (C_D = 1.0)
ΔZ = height of protrusion (ft)
b = block width perpendicular to flow (ft)
ρ = density of water (1.94 slugs/ft³)
V = velocity (ft/s)

The added lift force (F'_L) due to the block protruding above the ACB matrix is assumed equal to the drag force.

Unvegetated	F'_d =	0.00
Vegetated	F'_d =	0.00

Unvegetated	F'_L =	0.00
Vegetated	F'_L =	0.00

Note: Drag and Lift forces are ZERO using tapered block series, as ΔZ = 0

Calculate aθ (projection of Ws into subgrade beneath block):

Channel Geometry

Channel Slope (ft/ft)	0.053
Channel Slope (degrees)	3.01
Side Slope (_H:1V)	4.00
Side Slope (degrees)	14.04

θ_0 =	3.01	deg
θ_1 =	14.04	deg
a_θ =	0.969	

$$a_\theta = \sqrt{\cos^2\theta_1 - \sin^2\theta_0}$$

$$\theta_0 = \text{ATAN}(\text{bed slope})$$ *bed slope of embankment face section*

$$\theta_1 = \text{ATAN}\left(\frac{1}{\text{channel slope}}\right)$$ *side slope of embankment face section*

Calculate θ:

θ = 11.86 deg

$$\theta = \arctan\left(\frac{\sin\theta_0}{\sin\theta_1} \times \frac{\cos\theta_1}{\cos\theta_0}\right) = \arctan\left(\frac{\tan\theta_0}{\tan\theta_1}\right)$$

Calculate β:

	num	0.96653276
Unvegetated	denom	0.93
Vegetated	denom	0.81
Unvegetated	β =	46.24
Vegetated	β =	49.87

$$\beta = \arctan\left(\frac{\cos(\theta_0 + \theta)}{\left(\frac{\ell_4}{\ell_3} + 1\right)\frac{\sqrt{1 - a_\theta^2}}{\eta_0\left(\frac{\ell_2}{\ell_1}\right)} + \sin(\theta_0 + \theta)}\right)$$

Project:	By:	Date:
Possum Point	SCHELAB	8/18/2015
Pond D	Checked:	Date:
Location:	BERKEME	8/19/2015
Channel D-4A		

gai consultants

Calculate Stability Number for a Sloped Surface:

Unvegetated	num	3.94
Vegetated	num	3.97
	denom	4.066
Unvegetated	η_1 =	0.298
Vegetated	η_1 =	0.360

$$\eta_1 = \left(\frac{\frac{\ell_4}{\ell_3} + \sin(\theta_0 + \theta + \beta)}{\frac{\ell_4}{\ell_3} + 1} \right) \eta_0$$

Calculate Angle Between Drag Force and Block Motion:

Unvegetated	δ =	31.91
Vegetated	δ =	28.28

$$\delta = 90^\circ - \beta - \theta$$

Calculate Factor of Safety for Proposed Block (SF):

	num	4.75
Unvegetated	denom	1.63
Vegetated	denom	1.92
Unvegetated	SF =	2.91
Vegetated	SF =	2.47

$$FS = \frac{\left(\frac{\ell_2}{\ell_1}\right) a_\theta}{\sqrt{1 - a_\theta^2} \cos\beta + \eta_1 \left(\frac{\ell_2}{\ell_1}\right) + \frac{(\ell_3 F'_D \cos\delta + \ell_4 F'_L)}{\ell_1 w_S}}$$

Block Name:	ACB Cell Type:	Cable Direction:	Size:	Units:	ℓ_1	ℓ_2	ℓ_3	ℓ_4	W_b	W_s	b	t_c	G_s	ΔZ	ρ
					ft / m	ft / m	ft / m	ft / m	lb / N	lb / N	ft / m	lb/ft^2 / N/m	unitless	ft / m	$slugs/ft^3$ / kg/m^3
BD 400 OC	Open Cell	Bi-Directional	400	English Units	0.167	0.926	0.267	0.926	59	31	1.38	4.9	2.1	0.04	1.94
BD 400 OC	Open Cell	Bi-Directional	400	SI Units	0.051	0.282	0.081	0.282	262	137	0.42	234.6	2.1	0.01	1000
BD 400 CC	Closed Cell	Bi-Directional	400	English Units	0.167	0.926	0.267	0.926	69	36	1.38	5.7	2.1	0.04	1.94
BD 400 CC	Closed Cell	Bi-Directional	400	SI Units	0.051	0.282	0.081	0.282	307	161	0.42	272.9	2.1	0.01	1000
H 400 OC	Open Cell	None (Hand Placed)	400	English Units	0.167	0.833	0.267	0.833	32	17	1.00	5.1	2.2	0.04	1.94
H 400 OC	Open Cell	None (Hand Placed)	400	SI Units	0.051	0.254	0.081	0.254	142	78	0.30	244.2	2.2	0.01	1000
H 400 CC	Closed Cell	None (Hand Placed)	400	English Units	0.167	0.833	0.267	0.833	39	21	1.00	6.2	2.2	0.04	1.94
H 400 CC	Closed Cell	None (Hand Placed)	400	SI Units	0.051	0.254	0.081	0.254	173	95	0.30	296.9	2.2	0.01	1000
SD 475 OC	Open Cell	Single Directional	475	English Units	0.198	0.971	0.317	0.971	65	35	1.292	11.8	2.2	0.04	1.94
SD 475 OC	Open Cell	Single Directional	475	SI Units	0.060	0.296	0.097	0.296	289	158	0.39	565.0	2.2	0.01	1000
SD 475 CC	Closed Cell	Single Directional	475	English Units	0.198	0.971	0.317	0.971	74	40	1.292	16.7	2.2	0.04	1.94
SD 475 CC	Closed Cell	Single Directional	475	SI Units	0.060	0.296	0.097	0.296	329	180	0.39	799.6	2.2	0.01	1000
SD 475 OCT	Tapered Open Cell	Single Directional	475	English Units	0.198	0.971	0.317	0.971	65	35	1.292	25.9	2.2	0	1.94
SD 475 OCT	Tapered Open Cell	Single Directional	475	SI Units	0.060	0.296	0.097	0.296	289	158	0.39	1240.1	2.2	0.00	1000
BD 500 OC	Open Cell	Bi-Directional	500	English Units	0.208	0.926	0.333	0.926	74	39	1.38	5.7	2.1	0.04	1.94
BD 500 OC	Open Cell	Bi-Directional	500	SI Units	0.063	0.282	0.101	0.282	329	172	0.42	272.9	2.1	0.01	1000
BD 500 CC	Closed Cell	Bi-Directional	500	English Units	0.208	0.926	0.333	0.926	85	45	1.38	6.5	2.1	0.04	1.94
BD 500 CC	Closed Cell	Bi-Directional	500	SI Units	0.063	0.282	0.101	0.282	378	198	0.42	311.2	2.1	0.01	1000
H 500 OC	Open Cell	None (Hand Placed)	500	English Units	0.208	0.833	0.333	0.833	40	22	1.00	6.1	2.2	0.04	1.94
H 500 OC	Open Cell	None (Hand Placed)	500	SI Units	0.063	0.254	0.101	0.254	178	97	0.30	292.1	2.2	0.01	1000
H 500 CC	Closed Cell	None (Hand Placed)	500	English Units	0.208	0.833	0.333	0.833	49	27	1.00	7.5	2.2	0.04	1.94
H 500 CC	Closed Cell	None (Hand Placed)	500	SI Units	0.063	0.254	0.101	0.254	218	119	0.30	359.1	2.2	0.01	1000
SD 600 OC	Open Cell	Single Directional	600	English Units	0.25	0.971	0.4	0.971	88	48	1.292	17.2	2.2	0.04	1.94
SD 600 OC	Open Cell	Single Directional	600	SI Units	0.076	0.296	0.122	0.296	391	214	0.39	823.5	2.2	0.01	1000
SD 600 CC	Closed Cell	Single Directional	600	English Units	0.25	0.971	0.4	0.971	100	55	1.292	21.3	2.2	0.04	1.94
SD 600 CC	Closed Cell	Single Directional	600	SI Units	0.076	0.296	0.122	0.296	445	243	0.39	1019.8	2.2	0.01	1000
BD 600 OC	Open Cell	Bi-Directional	600	English Units	0.25	0.926	0.4	0.926	88	46	1.38	6.4	2.1	0.04	1.94
BD 600 OC	Open Cell	Bi-Directional	600	SI Units	0.076	0.282	0.122	0.282	391	205	0.42	306.4	2.1	0.01	1000
BD 600 CC	Closed Cell	Bi-Directional	600	English Units	0.25	0.926	0.4	0.926	105	55	1.38	7.6	2.1	0.04	1.94
BD 600 CC	Closed Cell	Bi-Directional	600	SI Units	0.076	0.282	0.122	0.282	467	245	0.42	363.9	2.1	0.01	1000
H 600 OC	Open Cell	None (Hand Placed)	600	English Units	0.250	0.833	0.400	0.833	49	27	1.00	7.4	2.2	0.04	1.94
H 600 OC	Open Cell	None (Hand Placed)	600	SI Units	0.076	0.254	0.122	0.254	218	119	0.30	354.3	2.2	0.01	1000
H 600 CC	Closed Cell	None (Hand Placed)	600	English Units	0.250	0.833	0.400	0.833	59	32	1.00	8.9	2.2	0.04	1.94
H 600 CC	Closed Cell	None (Hand Placed)	600	SI Units	0.076	0.254	0.122	0.254	262	143	0.30	426.1	2.2	0.01	1000
SD 600 OCT	Tapered Open Cell	Single Directional	600	English Units	0.25	0.971	0.4	0.971	88	48	1.292	31.2	2.2	0	1.94
SD 600 OCT	Tapered Open Cell	Single Directional	600	SI Units	0.076	0.296	0.122	0.296	391	214	0.39	1493.9	2.2	0.00	1000
BD 800 OC	Open Cell	Bi-Directional	800	English Units	0.333	0.926	0.533	0.926	120	63	1.38	7.6	2.1	0.04	1.94
BD 800 OC	Open Cell	Bi-Directional	800	SI Units	0.101	0.282	0.162	0.282	534	280	0.42	363.9	2.1	0.01	1000
BD 800 CC	Closed Cell	Bi-Directional	800	English Units	0.333	0.926	0.533	0.926	140	73	1.38	7.6	2.1	0.04	1.94
BD 800 CC	Closed Cell	Bi-Directional	800	SI Units	0.101	0.282	0.162	0.282	623	326	0.42	363.9	2.1	0.01	1000
SD 900 OC	Open Cell	Single Directional	900	English Units	0.375	0.971	0.6	0.971	132	72	1.292	23	2.2	0.04	1.94
SD 900 OC	Open Cell	Single Directional	900	SI Units	0.114	0.296	0.183	0.296	587	320	0.39	1101.2	2.2	0.01	1000
SD 900 CC	Closed Cell	Single Directional	900	English Units	0.375	0.971	0.6	0.971	150	82	1.292	28	2.2	0.04	1.94
SD 900 CC	Closed Cell	Single Directional	900	SI Units	0.114	0.296	0.183	0.296	667	364	0.39	1340.6	2.2	0.01	1000
BD 900 OC	Open Cell	Bi-Directional	900	English Units	0.375	0.926	0.6	0.926	135	71	1.38	8.1	2.1	0.04	1.94
BD 900 OC	Open Cell	Bi-Directional	900	SI Units	0.114	0.282	0.183	0.282	600	315	0.42	387.8	2.1	0.01	1000
BD 900 CC	Closed Cell	Bi-Directional	900	English Units	0.375	0.926	0.6	0.926	159	83	1.38	9.5	2.1	0.04	1.94
BD 900 CC	Closed Cell	Bi-Directional	900	SI Units	0.114	0.282	0.183	0.282	707	370	0.42	454.9	2.1	0.01	1000
SD 900 OCT	Tapered Open Cell	Single Directional	900	English Units	0.375	0.971	0.6	0.971	132	72	1.292	39.7	2.2	0	1.94
SD 900 OCT	Tapered Open Cell	Single Directional	900	SI Units	0.114	0.296	0.183	0.296	587	320	0.39	1900.8	2.2	0.00	1000

ACF Environmental
2831 Cardwell Road
Richmond, VA 23234
Phone: 1-800-271-2363

TEK 11-12
Factor of Safety Calculations
NCMA ACB Design Calculations

Project Design Parameters

V	18.5	Velocity (ft/sec)
τ	8.25	Design Shear (lb/ft^2)
S_b	0.0525	Bed Slope (ft/ft)
SS	4	Side Slope (_H:1V)

Block Properties

ℓ_1	0.198	ft
ℓ_2	0.971	ft
ℓ_3	0.317	ft
ℓ_4	0.971	ft
W_b	65	lb
b	1.292	ft
τ_c	25.9	lb/ft^2
S_c	2.2	Sp. Gr.
ΔZ	0	in
SS	0.250	ft/ft
K_b	1	
L	1.45	ft
ρ	1.94	slugs/ft^3

θ_0 - Channel Bed Slope = 3.005 deg 0.052 rad

θ_1 - Channel Side Slope = 14.036 deg 0.245 rad

W_s - Submerged Block Weight

$W_s = W_b*(S_c-1)/S_c =$ 35.455 lbs

η_0 - Stability Number Horizontal Surface

$\eta_0 = \tau / \tau_c =$ 0.319

$F_D = F_L$ - Additional Lift & Drag Forces from ΔZ

$F_L = F_D = 0.5*\Delta Z*b*\rho*V^2 =$ 0.000 lbs

$a_\theta = (\cos^2(\theta_1) - \sin^2(\theta_0))^{0.5}$

$a_\theta =$ 0.969

$\theta = \arctan((\sin(\theta_0) * \cos(\theta_1))/(\sin(\theta_1)*\cos(\theta_0))$

$\theta =$ 11.860 deg 0.207 rad

$\beta = \text{Arctan}((\cos(\theta_0+\theta)/((l_4/l_3+1)*(1-a_\theta^2)^{0.5}/(\eta_0*l_2/l_1)+\sin(\theta_0+\theta))$

$\beta =$ 46.979 deg 0.820 rad

$\eta_1 = (l_4/l_3+\sin(\theta_0+\theta+\beta))/(l_4/l_3+1))*\eta_0$ = Stability Number for Sloped Surface

$\eta_1 =$ 0.309

$\delta = 90 - \beta - \theta$ - Angle between F_D and Block Motion

$\delta =$ 31.16 deg 0.544 rad

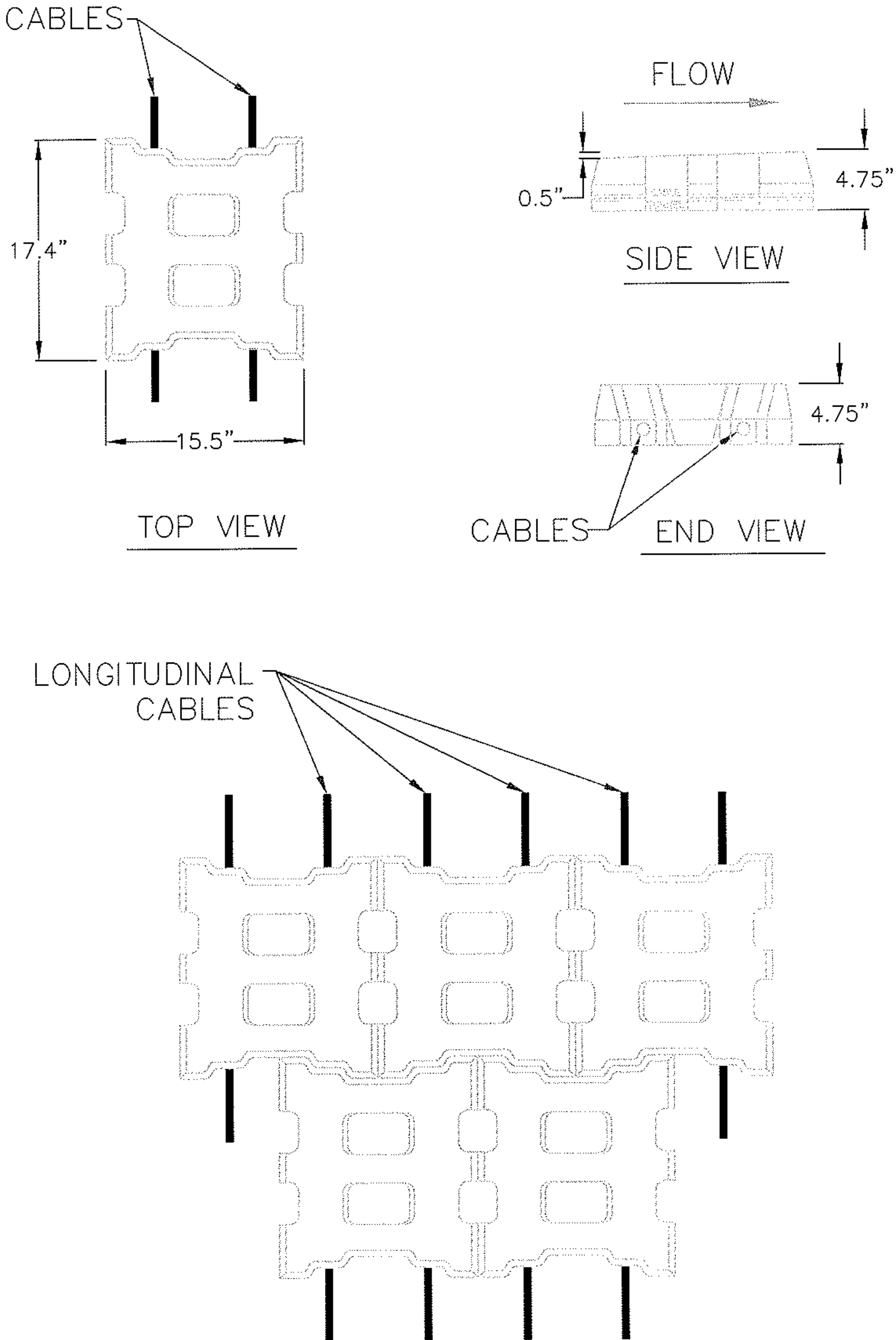
Factor of Safety

$FOS = (l_2/l_1*\theta_0) / ((1-a_\theta^2)^{0.5} * \cos(\beta) + \eta_1 * (l_2/l_1) + (l_3*F_D*\cos(\delta) + l_4 * F_L)/(l_1*W_s))$

FOS = **2.8**

Unit Recommended = SD 475 OCT

All risks in using this spreadsheet are to be undertaken by the user. ACF / Shoretec assumes no liability or responsibility for its accuracy or interpretation of the results generated. Design parameters namely moment arms, block weights and critical shears (τ_c) are assumed to be correct as they appear on this sheet, but should be verified with ACF / Shoretec by the user. AC F / Shoretec assumes no liabilities for the accuracy of the site data and hydraulic information used in this report as they are generated by parties not affiliated with them.



SD-475-OCT UNIT

Drawing N.T.S.

ACF ENVIRONMENTAL 2831 Cardwell Road Richmond, VA. 23234 Phone (804) 271-2363 www.acfenvironmental.com	Project:		Drawn By:	McCoy Drafting and Design, LLC.
	Customer:		Checked By:	Jim Nadeau
	Job #:		Date:	JAN. 24, 2012

GAI Project C150132.00

By SCHELAB 10/7/2015
Checked by BERKEME 10/14/2015

Pond E Closure
Energy Dissipator for Channel E-2A

Purpose:

A riprap basin will be constructed as outlet protection.
Establish the dimensions of the riprap basin necessary to dissipate the anticipated peak flow in the fabric form lined channel.

Reference:

1) U.S. Department of Transportation, Federal Highway Administration, Hydraulic Engineering Circular No. 14, Third Edition, Hydraulic Design of Energy Dissipators for Culverts and Channels. (HEC-14)
2) Channel Design for Channel E-2A.

Given:

D =	0.45	ft	flow depth in channel E-2A
n =	0.015		Manning's roughness value for fabric form
Q =	50	cfs	Peak design discharge
V_o =	28.3	fps	Peak outlet velocity

Methodology:

With the above given information, provide a riprap basin of suitable dimension and lining to protect from erosive outlet forces.
Use procedures in HEC-14.

Calculate:

A =	1.76	sq. ft.	Flow area in channel
y_e =	0.45	ft	Equivalent brink (outlet) depth

Assume that a low tailwater condition will apply - leads to greater pool depth

C_o = 1.40 Tailwater parameter, Equation 10.2, Reference 1

$$C_o = 1.4 \quad TW/y_e < 0.75$$
$$C_o = 4.0(TW/y_e) - 1.6 \quad 0.75 < TW/y_e < 1.0 \qquad (10.2)$$
$$C_o = 2.4 \quad 1.0 < TW/y_e$$

Use VDOT Class AI riprap : D_{50} = 0.90 foot

$h_s/y_e = 0.86\,(D_{50}/y_e)^{-0.55} * (V_o/[\,g*y_e]^{1/2}) - C_o$ Equation 10.1, Reference 2

h_s/y_e = 2.97

Therefore, h_s = 1.34 ft Minimum Dissipator pool depth, use 2' depth 2 ft

For low tailwater conditions, h_s / D_{50} should be greater than 2 (Reference 1, page 10-5, step 2)

h_s/D_{50} = 2.22 Ok

D_{50} / y_e should be greater than 0.1 (Reference 1, page 10-5, step 2)

D_{50}/y_e = 2.00 Ok

Dissipation Pool: (Figures 10.1 and 10.2, Reference 1)

W_o =	3.00	ft	Width of apron at channel outlet, equal to the channel bottom width
L_s =	20.0	ft	Length of energy dissipating pool (10 h_s or 3W_o)
L_A =	10.0	ft	Length of apron (5h_s or W_o) - NOTE, APRON MAY NOT BE REQUIRED
L_B =	30.0	ft	Total length of basin

GAI Project C150132.00

By SCHELAB 10/7/2015
Checked by BERKEME 10/14/2015

Pond E Closure
Energy Dissipator for Channel E-2A

BASIN EXIT CONDITIONS

W_B = 16.3 ft Basin width at the basin exit

Basin exit depth and exit velocity:
From HEC-14, exit depth and exit velocity are equal to critical depth and critical velocity

$Q^2 / g = (A_c)^3 / T_c = [\, y_c (W_B + zy_c)\,]^3 / (W_B + 2zy_c)$ Reference 1, Equation 7.14
$V_c = Q / A_c$
z = basin side slope
Basin exit depth is equal to y_c, and exit velocity is equal to V_c

Iterate using the above parameters until an allowable exit velocity is determined.

Givens:

Q =	50	cfs
g =	32.2	ft^2/s
W_B =	16.3	ft

Q^2 / g = 78 ft^5
Assign z = 2
Solving, y_c = 0.783022 ft yields Q^2 / g = 141 ft^5

With this, A_c = 14.0 sf $[\, A_c = y_c (W_B + zy_c)\,]$
$V_c = Q / A_c$ = 3.57 ft/s

THIS VELOCITY CAN BE ACCOMODATED BY THE DOWNSTREAM CHANNEL LINING

SUBJECT Possum Point Pond Closure

Access Road Piping To Access Road Channel Calculations

BY RMC DATE 08/27/2015 PROJ. NO. C150132.00

CHKD. BY MWK DATE 09/1/2015 SHEET NO. 1 OF 2

Introduction

SDR 21 HDPE culverts will be installed to convey stormwater from the perimeter access road channel into the access road channels. The contributing and individual watersheds are shown on Figure 1. The culverts will be designed to convey a 25-year storm into the proposed access road channels (See Figure 1) and will be installed directly on top of the proposed final grade.

Requirements

- The 22 SDR 21 HDPE culverts and Access Road Channels will be designed based upon the largest flow rate generated by the 25-year storm from the watersheds shown on Figure 1.

References

- Urban Hydrology for Small Watersheds, TR-55. United States Department of Agriculture, 1986
- Virginia Erosion and Sedimentation Control Handbook, Virginia Department of Environmental Quality, 1992.

Design Procedure

Using the references above and the provided information below the access road culverts to access road channels were designed.

Culvert Design Criteria:

- SDR 21 HDPE culvert will be evaluated for the design.
  - Rock check dams will be installed in the perimeter channel to direct stormwater through the access road culverts.
- The culverts were sized based on a peak flow of 19.56 CFS (See Attachment A).
- The culverts will outlet into the access road channels which are to be spaced at a maximum of 300 feet based on the outlet location within the interior channels.
- The maximum velocity coming out of any culvert is estimated to be 7.95 FPS, which is within the limits of the proposed channel lining material. (See Attachment B)
- The channel lining was selected considering the maximum estimated 25-year flow to any given channel (19.56 cfs).

Final Design

A 24" diameter culvert is capable of passing the design flow rate of 19.56 CFS. The access road culverts and access road channels will be designed in accordance with the construction specifications. The culvert sizing will refer to Attachment B. The access road channel sizing will refer to Attachment C.

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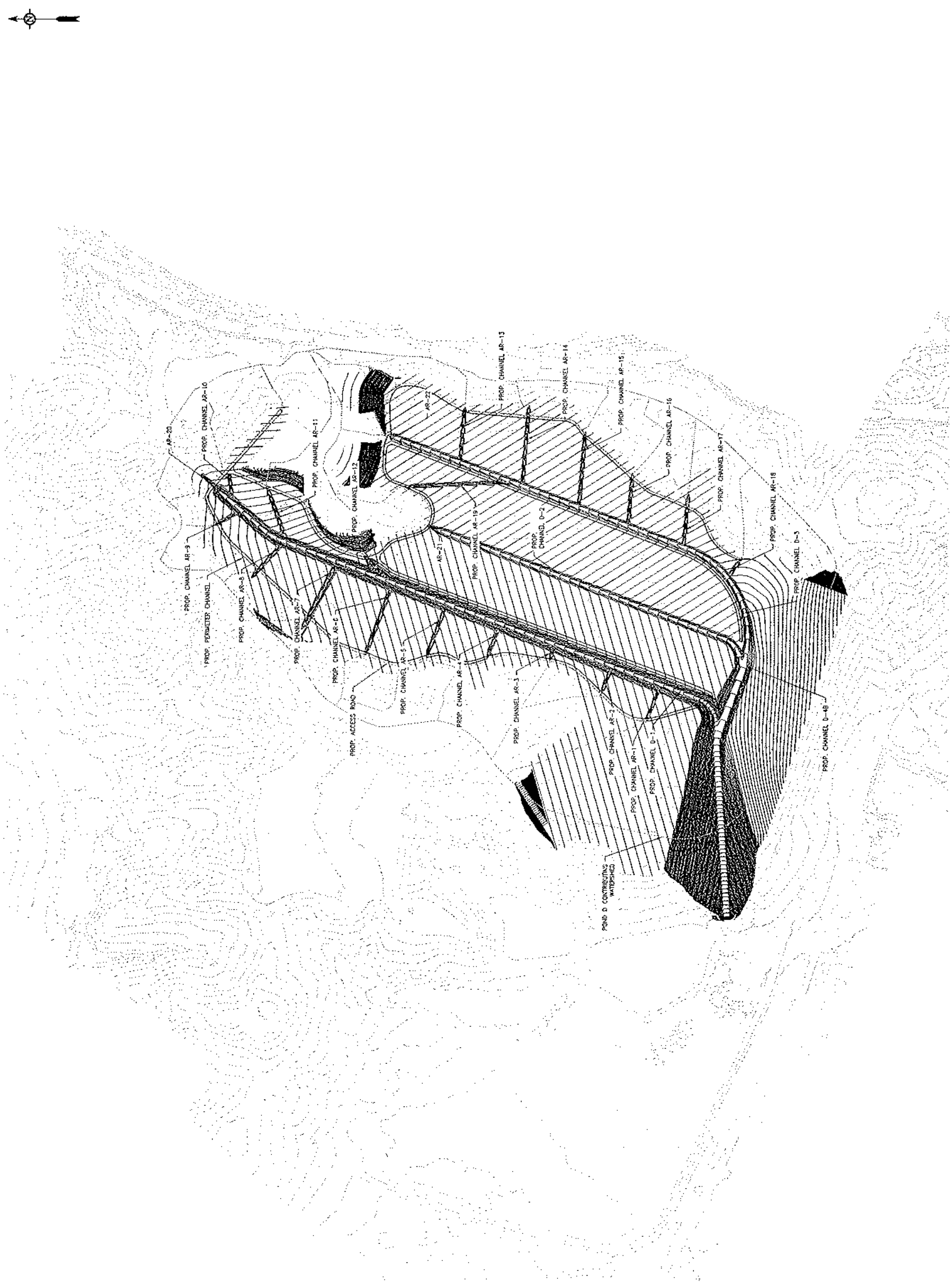
Figure 1


PROP. CHANNEL AR-13
PROP. CHANNEL AR-14
PROP. CHANNEL AR-15
PROP. CHANNEL AR-16
PROP. CHANNEL AR-17
PROP. CHANNEL AR-18
PROP. CHANNEL D-3
PROP. CHANNEL D-4B
AR-22
PROP. CHANNEL D-2
AR-21
PROP. CHANNEL AR-19
PROP. CHANNEL AR-12
PROP. CHANNEL AR-11
PROP. CHANNEL AR-10
AR-20
PROP. CHANNEL AR-9
PROP. PERIMETER CHANNEL
PROP. CHANNEL AR-8
PROP. CHANNEL AR-7
PROP. CHANNEL AR-6
PROP. CHANNEL AR-5
PROP. CHANNEL AR-4
PROP. CHANNEL AR-3
PROP. CHANNEL AR-2
PROP. CHANNEL AR-1
PROP. CHANNEL D-1
PROP. ACCESS ROAD
POND D CONTRIBUTING WATERSHED

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Attachment A

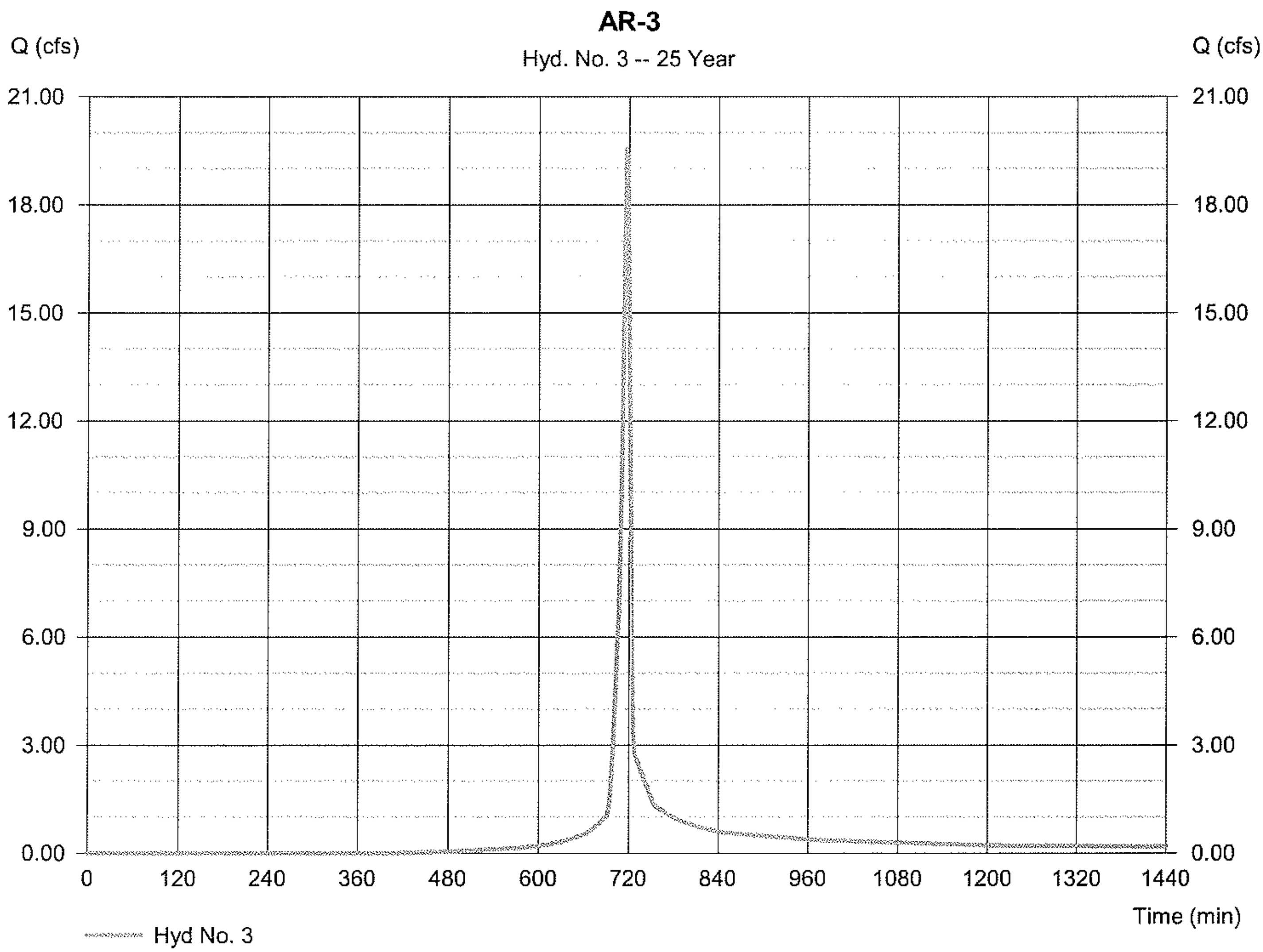
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Thursday, 08 / 27 / 2015

Hyd. No. 3

AR-3

Hydrograph type	= SCS Runoff	Peak discharge	= 19.56 cfs
Storm frequency	= 25 yrs	Time to peak	= 716 min
Time interval	= 2 min	Hyd. volume	= 39,923 cuft
Drainage area	= 3.230 ac	Curve number	= 78
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 6.00 min
Total precip.	= 6.06 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



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Attachment B

Culvert Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc.

Thursday, Aug 27 2015

Worst Case Scenario

Invert Elev Dn (ft)	= 136.50
Pipe Length (ft)	= 30.00
Slope (%)	= 1.00
Invert Elev Up (ft)	= 136.80
Rise (in)	= 24.0
Shape	= Circular
Span (in)	= 24.0
No. Barrels	= 1
n-Value	= 0.013
Culvert Type	= Circular Corrugate Metal Pipe
Culvert Entrance	= Projecting
Coeff. K,M,c,Y,k	= 0.034, 1.5, 0.0553, 0.54, 0.9

Embankment

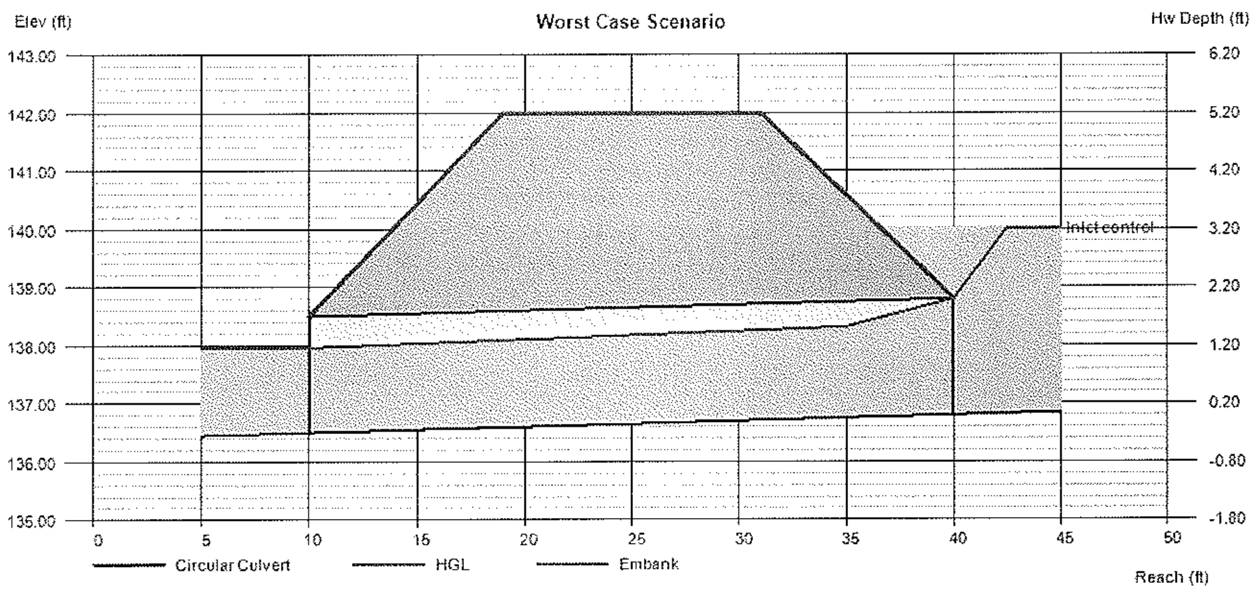
Top Elevation (ft)	= 142.00
Top Width (ft)	= 12.00
Crest Width (ft)	= 35.00

Calculations

Qmin (cfs)	= 19.56
Qmax (cfs)	= 19.56
Tailwater Elev (ft)	= Normal

Highlighted

Qtotal (cfs)	= 19.56
Qpipe (cfs)	= 19.56
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 7.95
Veloc Up (ft/s)	= 7.31
HGL Dn (ft)	= 137.96
HGL Up (ft)	= 138.39
Hw Elev (ft)	= 140.01
Hw/D (ft)	= 1.61
Flow Regime	= Inlet Control



Attachment C

CHANNEL DESIGN WORKSHEET
Channel Design Data

PROJECT NAME: Possum Point Power Station CCB Pond Closure
LOCATION: Prince William County, Virginia
PREPARED BY: RMC DATE: 8/21/2015
CHECKED BY: PATTEJR DATE: 9/10/2015

		1.50%	1.50%
CHANNEL OR CHANNEL SECTION	Units	Channel AR-3	Channel AR-3
Temporary or Permanent		Temporary	Permanent
Qr (REQUIRED CAPACITY)	CFS	19.56	19.56
Q (CALCULATED AT FLOW DEPTH d)	CFS	19.56	19.56
PROTECTIVE LINING		North American Green SC 250	Vegetated
n (MANNING'S COEFFICIENT)		0.030	0.058
Va (ALLOWABLE VELOCITY)	FPS	9.50	15.00
V (CALCULATED AT FLOW DEPTH d)	FPS	3.79	2.33
τ_a (MAX ALLOWABLE SHEAR STRESS)	LB/FT^2	3.00	10.00
τ_d (SHEAR STRESS @ FLOW DEPTH d)	LB/FT^2	0.95	1.21
CHANNEL BOTTOM WIDTH	FT	0.00	0.00
CHANNEL SIDE SLOPES (X:1)	H:V	5.00	5.00
D (TOTAL DEPTH)	FT	1.52	1.80
CHANNEL TOP WIDTH @ D	FT	15.16	17.97
d (CALCULATED FLOW DEPTH)	FT	1.02	1.30
CHANNEL TOP WIDTH @ FLOW DEPTH d	FT	10.16	12.97
BOTTOM WIDTH: FLOW DEPTH RATIO (12:1 MAX)		0.00	0.00
d_{50} STONE SIZE	IN	N/A	N/A
A (CROSS SECTIONAL AREA)	SQ FT	5.16	8.41
R (HYDRAULIC RADIUS)		0.50	0.64
S (BED SLOPE)[3]	FT/FT	0.015	0.015

Proposed Channel Dimensions & Linings	
Base	0.0
Required Depth	1.80
Design Depth	2.0
Z = H:V	5.0
Top Width	20.0
Lining	SC 250 / Vegetated
Lining Longevity	Permanent

APPENDIX C
Sedimentation Basin Design

APPENDIX C

TABLE OF CONTENTS:

*Appendix sheet numbers correspond to red numbers in the upper right hand corner of each page.

INTRODUCTION

This calculation will size two (2) proposed temporary sediment basins and associated outlet structures required for sediment control during construction. Storage and discharge requirements are based on the Virginia Erosion and Sediment Control (E&S) handbook.

REFERENCES

1. Virginia E&S Control Handbook, Virginia Department of Environmental Quality, 1992.
2. Site Hydrology Calculations (included in this calculation booklet).
3. Phase II grading plan for Pond ABC.
4. Technical Manual: Overtopping Protection for Dams, Chapter 8, Federal Emergency Management Agency, May 2014.

ATTACHMENTS

1. Pond Pack Spillway Rating Curves
2. HEC-HMS Input
3. HEC-HMS Output
4. Erosion Protection Calculations
5. Filter Diaphragm Calculations

STORAGE REQUIRED

From the Virginia E&S Regulations, the following storage criteria are utilized for the Sedimentation Basin:

- Capacity of at least 134 cubic yards per contributing acre
- 67 cubic yards per acre is to be permanent pool
- 67 cubic yards is to be drawdown area
- Sediment cleanout shall occur when wet storage is reduced to 34 cubic yards per acre (sediment occupies 33 cubic yards per acre)

Storage Required continued

The Sedimentation Basins will be utilized once CCB material has been completely removed from Pond ABC, thus runoff will only contain soil particles and not CCB material.

Two Sediment Basins will be utilized.

Sed Pond B

20.8	acres total draining to Pond
67	cy per watershed acre of wet volume yields
1,394	cy wet volume required
0.86	acre-feet wet volume required
67	cy per watershed acre of dry volume yields
1,394	cy dry volume required
0.86	acre-feet dry volume required
33	cy per watershed acre required sediment cleanout volume, maximum
686	cy volume at maximum sediment cleanout level
0.43	acre-feet volume at maximum sediment cleanout level

Sed Pond C

15.9	acres total draining to Pond
67	cy per watershed acre of wet volume yields
1,065	cy wet volume required
0.66	acre-feet wet volume required
67	cy per watershed acre of dry volume yields
1,065	cy dry volume required
0.66	acre-feet dry volume required
33	cy per watershed acre required sediment cleanout volume, maximum
525	cy volume at maximum sediment cleanout level
0.33	acre-feet volume at maximum sediment cleanout level

SUBJECT POSSUM POINT CCR POND CLOSURES
SEDIMENT BASIN DESIGN – PONDS ABC

BY SCHELAB DATE 8/26/2015 PROJ. NO. C150132.00

CHKD. BY PATTEJR DATE 8/31/2015

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STORAGE PROVIDED

Assess the storage provided in the Sedimentation Basins and establish required wet and dry storage levels. Use average areas between elevations to calculate volume. Surface areas at the index elevations are taken from the Phase II Grading Plan for Pond ABC (Reference 3).

Sed Pond B

Elevation (ft)	Surface Area (ft^2)	Surface Area (ac)	Incremental Volume (cf)	Incremental Volume (ac-ft)	Total Volume (cf)	Total Volume (ac-ft)	
10	21,152	0.49	0	0.00	0	0.00	
11	28,944	0.66	25048	0.58	25,048	0.58	<--- Sediment Cleanout Elevation
12	41,812	0.96	35378	0.81	60,426	1.39	<--- Wet Volume Elevation (Orifice Invert)
13	67,778	1.56	54795	1.26	115,221	2.65	<--- Dry Volume Elevation (Riser Crest)
14	112,525	2.58	90152	2.07	205,373	4.71	<--- Emergency Spillway Crest
15	137,600	3.16	125063	2.87	330,435	7.59	
16	172,751	3.97	155176	3.56	485,611	11.15	
17	193,606	4.44	183179	4.21	668,789	15.35	
18	217,493	4.99	205550	4.72	874,339	20.07	

Sed Pond C

Elevation (ft)	Surface Area (ft^2)	Surface Area (ac)	Incremental Volume (cf)	Incremental Volume (ac-ft)	Total Volume (cf)	Total Volume (ac-ft)	
10	23,183	0.53	0	0.00	0	0.00	
11	25,553	0.59	24,368	0.56	24,368	0.56	<--- Sediment Cleanout Elevation
12	28,560	0.66	27,057	0.62	51,425	1.18	<--- Wet Volume Elevation (Orifice Invert)
13	45,615	1.05	37,088	0.85	88,512	2.03	<--- Dry Volume Elevation (Riser Crest)
14	71,064	1.63	58,340	1.34	146,852	3.37	<--- Emergency Spillway Crest
15	90,737	2.08	80,901	1.86	227,752	5.23	
16	117,240	2.69	103,989	2.39	331,741	7.62	
17	139,595	3.20	128,418	2.95	460,158	10.56	
18	173,012	3.97	156,304	3.59	616,462	14.15	

DISCHARGE REQUIREMENTS

From the Virginia E&S Regulations, the principal and emergency spillways must meet the following:

- The principal spillway must pass the peak flow from a 2-year 24-hour storm;
- The two spillways combined must be capable of discharging the peak flow from a 25-year 24-hour storm with a minimum freeboard of one foot;
- The principal spillway riser crest must be a minimum of one foot below the emergency spillway crest.

Both Basins will use the following Spillway Configuration:

- 2.0-foot diameter High Density Polyethylene (HDPE) pipe used as a riser (crest elevation 13 feet)
- 1.0-foot diameter HDPE pipe used as a barrel
(Upstream Invert = 11 feet, Downstream Invert = 10 feet)
- Trapezoidal emergency spillway with a 4-foot bottom width and 2:1 side slopes). Crest elevation is 14.0 (1.0 feet above the principal spillway crest).The emergency spillway will be constructed of riprap.

HYDRAULIC ANALYSIS

A rating curve for the spillway structure identified above is developed using the composite outlet structures feature of Pond Pack Version 8i (Attachment 1). The rating curve is then input into the HEC-HMS model for the site (Site Hydrology Calculations).

The 2-year and 25-year storms are routed through the Sedimentation Basins for the fully disturbed runoff condition.

HEC-HMS output data is included as Attachment 3.

ADDITIONAL DESIGN FEATURES

Principal Spillway Outlet Protection

Outlet protection for the 12-inch principal spillway barrels is sized to protect against erosion for the 25-year storm based on Sections 3.18 (Outlet Protection) and 3.19 (Riprap) of the Virginia E&S manual. Refer to Attachment 4 for apron sizing. The aprons should be installed per VDOT installation guidelines. The following apron dimensions are selected for design:

Riprap D_{50}	=	**0.9 feet (VDOT Class AI)**
Length	=	**10 feet**
Upstream Width	=	**3 feet**
Downstream Width	=	**11 feet**

Emergency Spillway Erosion Protection

Embankment erosion protection is provided downstream of the spillway control section. Design guidance is provided in Reference 4, and includes the following relationships for slopes up to 50% (2:1).

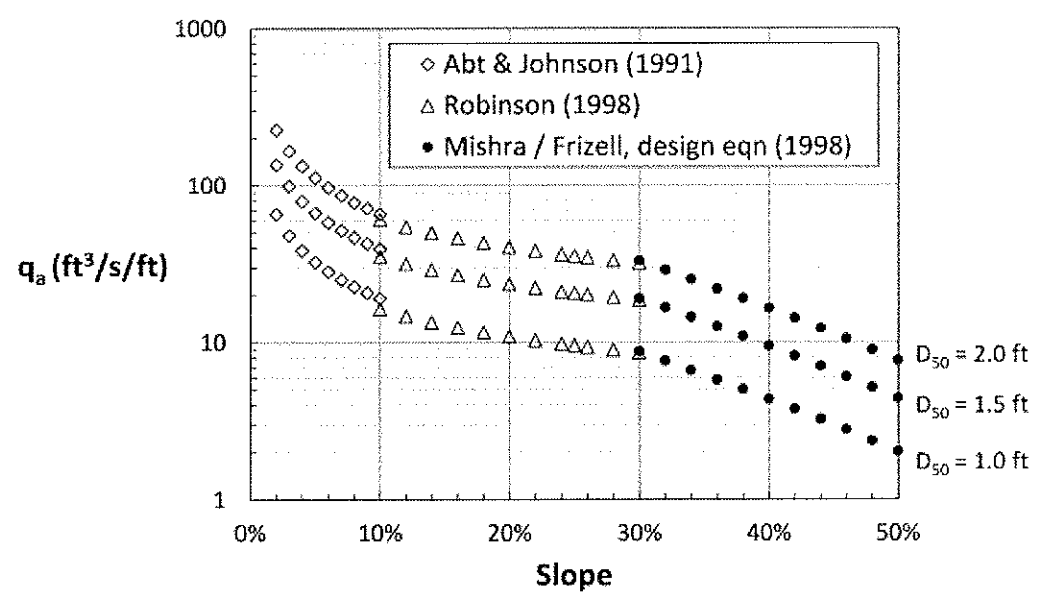

Figure 8-3.—Example calculation of allowable unit discharge as a function of slope, assuming a fixed stone size (Reclamation).

SUBJECT POSSUM POINT CCR POND CLOSURES
SEDIMENT BASIN DESIGN – PONDS ABC

BY SCHELAB DATE 10/13/2015 PROJ. NO. C150132.00

CHKD. BY PATTEJR DATE 10/14/2015

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Maximum 25-year flow through the spillways is estimated to be less than 2 cfs. This equates to 0.5 cfs/ft.

The embankment slope (S_t) = 0.33 ft/ft

From Figure 8-3 **Minimum D_{50} = Less than 1 ft**

Use VDOT Class AI Riprap (D_{50} = 0.9 ft)

ANTI-SEEP COLLARS

Determine the Length of the Barrel within the saturated zone:

$$L_s = Y(Z + 4)\left(1 + \frac{S}{0.25 - S}\right)$$

where:

L_s = length of barrel in the saturated zone, feet

Y = the depth of water at the principal spillway crest, feet

Z = slope of the upstream face of embankment in Z feet horizontal to one vertical

S = slope of the barrel in feet per foot

$Y = 2$ ft
$Z = 3$
$S = .014$ ft/ft
$L_s = 15$ ft
$L_f = 1.1 \times Ls = 16.5$ ft
Assume 2 Collars will be used
$V_{min} = 0.1 \times Ls / 4 = 0.4$ ft (use 1')
Spacing = $14 \times V_{min} = 5.6$ ft (use 6')

FILTER DIAPHRAGMS

Filter diaphragms may be used in lieu of Anti-Seep Collars. Refer to attached Filter Diaphragm calculation.

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SUBJECT POSSUM POINT CCR POND CLOSURES
SEDIMENT BASIN DESIGN – PONDS ABC

BY SCHELAB DATE 8/26/2015 PROJ. NO. C150132.00

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DEWATERING

Virginia E&S Regulations state that the dewatering orifice must dewater the dry storage volume in a minimum of 6 hours. From the regulations:

A = flow area of orifice, in square feet

d = diameter of circular orifice, in feet

h = average driving head (maximum possible head measured from radius of orifice to crest of principal spillway divided by 2), in feet

Q = volumetric flowrate through orifice needed to achieve approximate 6-hour drawdown, cubic feet per second

S = total storage available in dry storage area, cubic feet

Q = S / 21,600 seconds

Use S for basin and find Q. Then substitute in calculated Q and find A:

$$A = \frac{Q}{\left(64.32 \; x \; h\right)^{\frac{1}{2}} \; (0.6)}$$

Then, substitute in calculated A and find d:

$$d* = 2 \; x \left(\frac{A}{3.14}\right)^{\frac{1}{2}}$$

The Temporary Sediment Basins are designed to dewater in 12-hours.

SUBJECT POSSUM POINT CCR POND CLOSURES
SEDIMENT BASIN DESIGN – PONDS ABC

BY SCHELAB DATE 10/13/2015 PROJ. NO. C150132.00

CHKD. BY PATTEJR DATE 10/14/2015

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Dewatering continued

Sed Pond B			
S = dry storage available =		1.26	acre-feet
S =	54,886 cubic feet		
Use drawdown of	12 hours =	43,200	sec
Q = S / 43,200 seconds =		1.3	cfs
Invert elevation of orifice =		12	
Riser crest elevation =		13	
Average head =		0.50	feet
Orifice Diameter =		6.00	inches
Orifice Area =		0.20	sf
Number of Orifices =		2	
Flow Provided =		1.3	cfs
Dewatering Time =		11.4	hours

Sed Pond C			
S = dry storage available =		0.73	acre-feet
S =	31,799 cubic feet		
Use drawdown of	12 hours =	43,200	sec
Q = S / 43,200 seconds =		0.7	cfs
Invert elevation of orifice =		12	
Riser crest elevation =		13	
Average head =		0.50	feet
Orifice Diameter =		6.00	inches
Orifice Area =		0.20	sf
Number of Orifices =		2	
Flow Provided =		1.3	cfs
Dewatering Time =		6.6	hours

ATTACHMENT 1

POND PACK SPILLWAY RATING CURVES

Composite Outlet Structure Detailed Report: Sed Basin B

Element Details			
Label	Sed Basin B	Notes	

Headwater Range			
Headwater Type	User Defined Headwater	Increment (Headwater)	0.50 ft
Minimum (Headwater)	11.00 ft	Maximum (Headwater)	16.00 ft

SpotElevation (ft)

Tailwater Setup			
Tailwater Type	Free Outfall		

Tailwater Tolerances			
Maximum Iterations	30	Tailwater Tolerance (Maximum)	0.50 ft
Headwater Tolerance (Minimum)	0.01 ft	Flow Tolerance (Minimum)	0.001 ft³/s
Headwater Tolerance (Maximum)	0.50 ft	Flow Tolerance (Maximum)	10.000 ft³/s
Tailwater Tolerance (Minimum)	0.01 ft		

Outlet Structure			
Outlet Structure Type	Riser		

Outlet Structure (IDs and Direction)			
Outlet ID	Riser - 1	Downstream ID	Culvert - 1
Flow Direction	Forward and Reverse Flow	Notes	

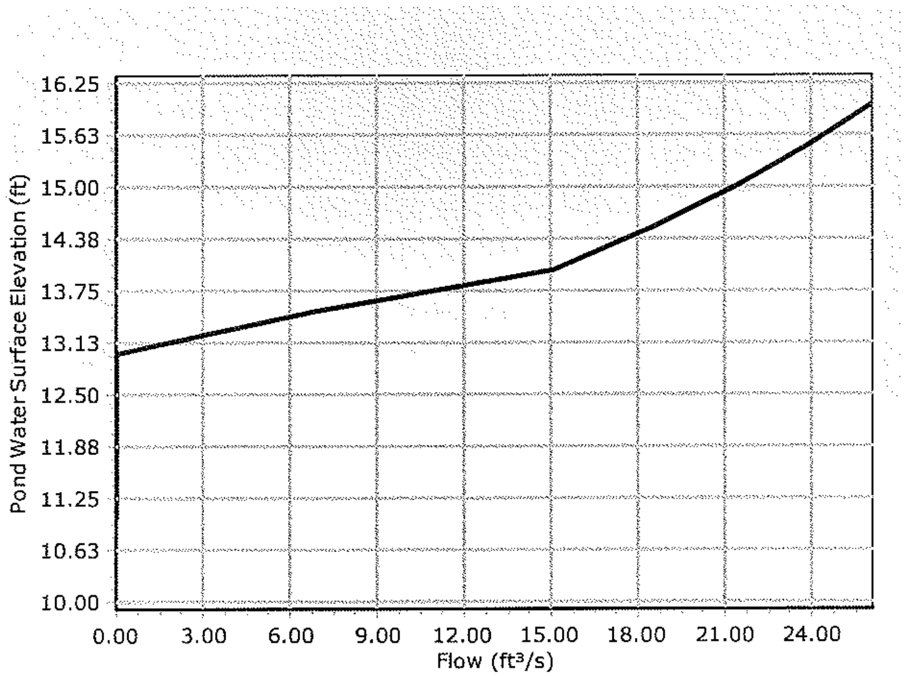
Outlet Structure (Advanced)			
Elevation (On)	0.00 ft	Elevation (Off)	0.00 ft

Outlet Structure (Riser)			
Riser	Stand Pipe	Transition Elevation	0.00 ft
Diameter	24.0 in	Transition Height	0.00 ft
Weir Coefficient	3.10 (ft^0.5)/s	K Reverse	1.000
Orifice Coefficient	0.600		

Outlet Structure (Common)			
Elevation	13.00 ft		

Outlet Structure (Riser, Advanced)			
Use Orifice Depth to Crest?	True	Use Submerged Weir Equation?	False

Composite Outlet Structure Detailed Report: Sed Basin B



RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Riser - 1 (Stand Pipe)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft^3/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)
11.00	0.00	0.00	0.00	0.00
11.50	0.00	0.00	0.00	0.00
12.00	0.00	0.00	0.00	0.00
12.50	0.00	0.00	0.00	0.00
13.00	0.00	0.00	0.00	0.00
13.50	6.89	13.50	13.50	13.50
14.00	15.12	14.00	14.00	14.00
14.50	18.52	14.50	14.50	14.50
15.00	21.38	15.00	15.00	15.00
15.50	23.91	15.50	15.50	15.50
16.00	26.19	16.00	16.00	16.00

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft^3/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00

Composite Outlet Structure Detailed Report: Sed Basin B

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Riser - 1 (Stand Pipe)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft^3/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00

Message
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
FULLY CHARGED RISER: ADJUSTED TO WEIR: H =0.5ft
FULLY CHARGED RISER, DOWNSTREAM CONTROL: Kev=0. Hev=0.000
FULLY CHARGED RISER, DOWNSTREAM CONTROL: Kev=0. Hev=0.000
FULLY CHARGED RISER, DOWNSTREAM CONTROL: Kev=0. Hev=0.000
FULLY CHARGED RISER, DOWNSTREAM CONTROL: Kev=0. Hev=0.000
FULLY CHARGED RISER, DOWNSTREAM CONTROL: Kev=0. Hev=0.000

Outlet Structure

Outlet Structure Type	Culvert	Culvert Type	Circular

Outlet Structure (IDs and Direction)

Outlet ID	Culvert - 1	Downstream ID	Tailwater
Flow Direction	Forward and Reverse Flow	Notes	

Outlet Structure (Advanced)

Composite Outlet Structure Detailed Report: Sed Basin B

Outlet Structure (Advanced)

Elevation (On)	0.00 ft	Elevation (Off)	0.00 ft

Culvert Data

Number of Barrels	1	Downstream Invert	10.00 ft
Length	70.00 ft	Diameter	12.0 in
Upstream Invert	11.00 ft		

Unsubmerged->Submerged

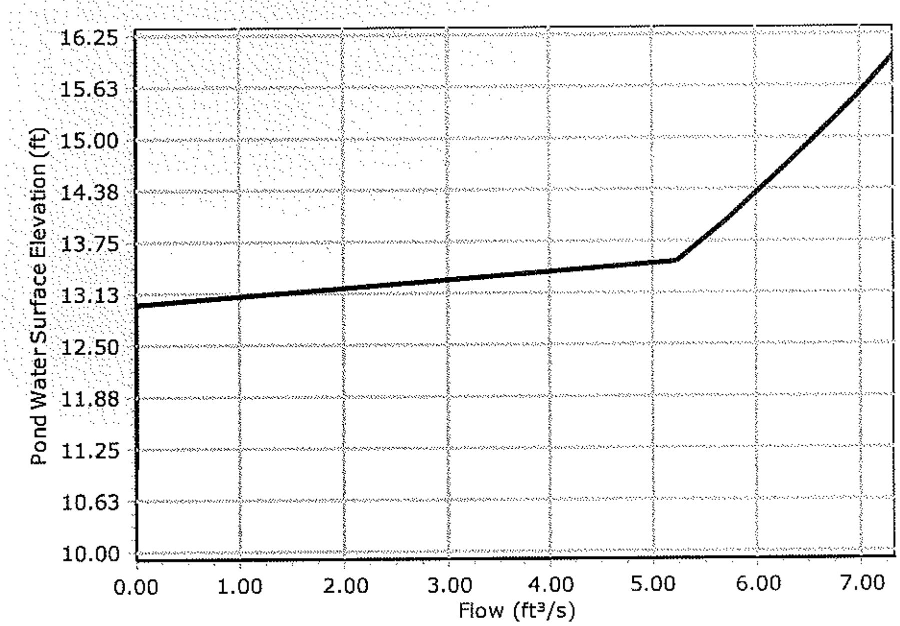
Specify Transitions	False	Compute Inlet Control Only	False

Culvert Coefficients

Inlet Description	Concrete - Square edge w/headwall	C	0.0398
Chart	Chart 1	Y	0.6700
Nomograph	Nomograph 1	Manning's n	0.013
Equation Form	Form 1	Ke	0.500
K	0.0098	Kr	0.000
M	2.0000	Slope Correction Factor	-0.500

Culvert (Advanced)

Convergence Tolerance	0.00 ft	Specify Number of Backwater Sections	False



Composite Outlet Structure Detailed Report: Sed Basin B

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Culvert - 1 (Culvert-Circular)

Mannings open channel maximum capacity: 4.58 ft³/s
Upstream ID = Riser - 1 (Stand Pipe)
Downstream ID = Tailwater (Pond Outfall)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)
11.00	0.00	0.00	0.00	Free Outfall
11.50	0.00	0.00	0.00	Free Outfall
12.00	0.00	0.00	0.00	Free Outfall
12.50	0.00	0.00	0.00	Free Outfall
13.00	0.00	0.00	0.00	Free Outfall
13.50	5.23	13.50	Free Outfall	Free Outfall
14.00	5.70	14.00	Free Outfall	Free Outfall
14.50	6.15	14.50	Free Outfall	Free Outfall
15.00	6.57	15.00	Free Outfall	Free Outfall
15.50	6.97	15.50	Free Outfall	Free Outfall
16.00	7.34	16.00	Free Outfall	Free Outfall

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	1.66	(N/A)	0.00
0.00	9.42	(N/A)	0.00
0.00	12.37	(N/A)	0.00
0.00	14.81	(N/A)	0.00
0.00	16.94	(N/A)	0.00
0.00	18.85	(N/A)	0.00

Message
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
FULL FLOW...Lfull=64.85ft Vh=.688ft HL=2.427ft Hev= .00ft
FULL FLOW...Lfull=67.97ft Vh=.819ft HL=2.970ft Hev= .00ft
FULL FLOW...Lfull=68.98ft Vh=.953ft HL=3.485ft Hev= .00ft
FULL FLOW...Lfull=69.38ft Vh=1.087ft HL=3.991ft Hev= .00ft

Composite Outlet Structure Detailed Report: Sed Basin B

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Culvert - 1 (Culvert-Circular)

Mannings open channel maximum capacity: 4.58 ft^3/s
Upstream ID = Riser - 1 (Stand Pipe)
Downstream ID = Tailwater (Pond Outfall)

Message
FULL FLOW...Lfull=69.60ft Vh=1.222ft HL=4.495ft Hev= .00ft
FULL FLOW...Lfull=69.78ft Vh=1.357ft HL=4.996ft Hev= .00ft

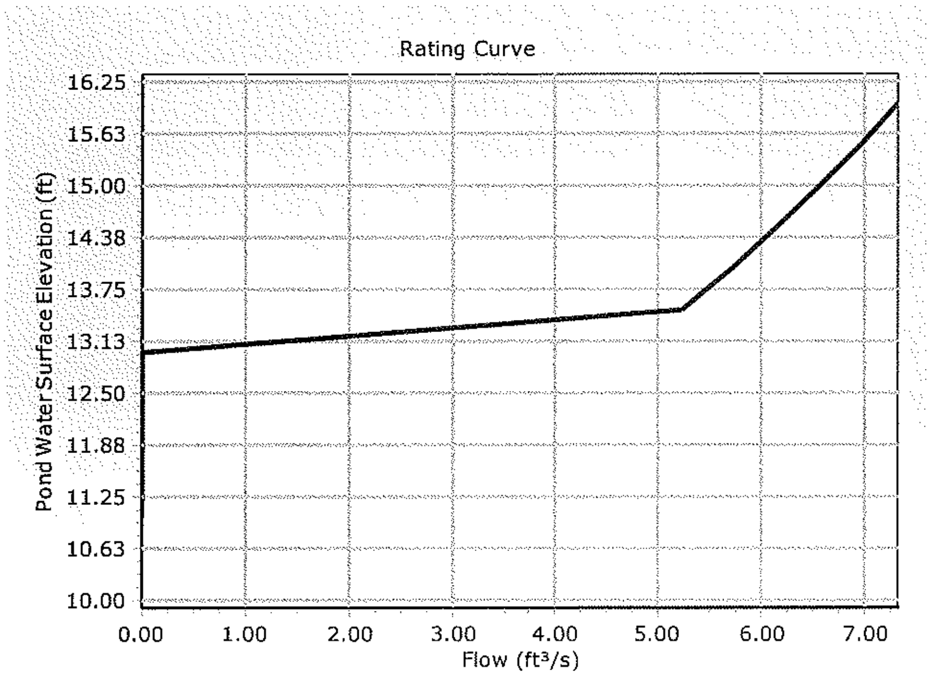
Composite Outlet Structure Detailed Report: Sed Basin B

Composite Rating Table
Tailwater Elevation = Free Outfall (Sed Basin B)

Water Surface Elevation (ft)	Flow (ft^3/s)	Tailwater Elevation (ft)	Convergence Error (ft)
11.00	0.00	(N/A)	0.00
11.50	0.00	(N/A)	0.00
12.00	0.00	(N/A)	0.00
12.50	0.00	(N/A)	0.00
13.00	0.00	(N/A)	0.00
13.50	5.23	(N/A)	0.00
14.00	5.70	(N/A)	0.00
14.50	6.15	(N/A)	0.00
15.00	6.57	(N/A)	0.00
15.50	6.97	(N/A)	0.00
16.00	7.34	(N/A)	0.00

Contributing Structures
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
Riser - 1,Culvert - 1
Riser - 1,Culvert - 1
Riser - 1,Culvert - 1
Riser - 1,Culvert - 1
Riser - 1,Culvert - 1
Riser - 1,Culvert - 1

Composite Outlet Structure Detailed Report: Sed Basin B



ATTACHMENT 2

HEC-HMS INPUT

PRINCIPAL SPILLWAY STAGE DISCHARGE CURVE

(DEVELOPED FROM PONDPACK MODELING, SAME FOR BOTH BASINS)

Paired Data | Table | Graph

Elevation (FT)	Discharge (CFS)
13.0	0.00
13.5	5.23
14.0	5.70
14.5	6.15
15.0	6.57
15.5	6.97
16.0	7.34

EMERGENCY SPILLWAY SPECIFICATIONS

(COMPUTED WITH HEC-HMS, SAME FOR BOTH BASINS)

Reservoir | Spillway 2 | Options

Basin Name: Pond ABC E&S
Element Name: Sed Pond C
Method: Broad-Crested Spillway
Direction: Main
*Elevation (FT) 14
*Length (FT) 4
*Coefficient (FT^0.5/S) 3
Gates: 0

SED BASIN B - STAGE STORAGE CURVE

(DEVELOPED FROM POND ABC PHASE II GRADING)

Paired Data | Table | Graph

Elevation (FT)	Area (AC)
10.0	0.48558
11.0	0.66446
12.0	0.95987
13.0	1.55600
14.0	2.58320
15.0	3.15890
16.0	3.96580

BASIN C - STAGE STORAGE CURVE

(DEVELOPED FROM POND ABC PHASE II GRADING)

Paired Data | Table | Graph

Elevation (FT)	Area (AC)
10.0	0.53221
11.0	0.58662
12.0	0.65565
13.0	1.04720
14.0	1.63140
15.0	2.08300
16.0	2.69150

ATTACHMENT 3

HEC-HMS OUTPUT

HEC-HMS OUTPUT

Sed Basin B: 2-Year, 24-Hour Storm

Summary Results for Reservoir "Sed Basin B"

Project: Possum Point Closures Simulation Run: 2-Year E&S
Reservoir: Sed Basin B

Start of Run:	30Mar2015, 00:00	Basin Model:	Pond ABC E&S
End of Run:	01Apr2015, 23:00	Meteorologic Model:	2-yr Storm
Compute Time:	28Aug2015, 16:48:35	Control Specifications:	Control 1

Volume Units: ○ IN ◉ AC-FT

Computed Results

Peak Inflow:	22.7 (CFS)	Date/Time of Peak Inflow:	30Mar2015, 11:58
Peak Discharge:	2.7 (CFS)	Date/Time of Peak Discharge:	30Mar2015, 12:32
Inflow Volume:	1.3 (AC-FT)	Peak Storage:	3.2 (AC-FT)
Discharge Volume:	1.3 (AC-FT)	Peak Elevation:	13.3 (FT)

Summary Results for Sink "B Principal"

Project: Possum Point Closures Simulation Run: 2-Year E&S
Sink: B Principal

Start of Run:	30Mar2015, 00:00	Basin Model:	Pond ABC E&S
End of Run:	01Apr2015, 23:00	Meteorologic Model:	2-yr Storm
Compute Time:	28Aug2015, 16:48:35	Control Specifications:	Control 1

Volume Units: ○ IN ◉ AC-FT

Computed Results

Peak Discharge:	2.7 (CFS)	Date/Time of Peak Discharge	30Mar2015, 12:32
Volume:	1.3 (AC-FT)		

Summary Results for Sink "B Emergency"

Project: Possum Point Closures Simulation Run: 2-Year E&S
Sink: B Emergency

Start of Run:	30Mar2015, 00:00	Basin Model:	Pond ABC E&S
End of Run:	01Apr2015, 23:00	Meteorologic Model:	2-yr Storm
Compute Time:	28Aug2015, 16:48:35	Control Specifications:	Control 1

Volume Units: ○ IN ◉ AC-FT

Computed Results

Peak Discharge:	0.0 (CFS)	Date/Time of Peak Discharge	30Mar2015, 00:00
Volume:	0.0 (AC-FT)		

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HEC-HMS OUTPUT

Sed Basin B: 25-Year, 24-Hour Storm

Summary Results for Reservoir "Sed Basin B"

Project: Possum Point Closures Simulation Run: 25-Year E&S
Reservoir: Sed Basin B

Start of Run:	30Mar2015, 00:00	Basin Model:	Pond ABC E&S
End of Run:	01Apr2015, 23:00	Meteorologic Model:	25-yr Storm
Compute Time:	28Aug2015, 16:51:25	Control Specifications:	Control 1

Volume Units: IN AC-FT

Computed Results

Peak Inflow:	78.8 (CFS)	Date/Time of Peak Inflow:	30Mar2015, 11:58
Peak Discharge:	5.8 (CFS)	Date/Time of Peak Discharge:	30Mar2015, 12:55
Inflow Volume:	4.7 (AC-FT)	Peak Storage:	4.9 (AC-FT)
Discharge Volume:	4.6 (AC-FT)	Peak Elevation:	14.1 (FT)

Summary Results for Sink "B Principal"

Project: Possum Point Closures Simulation Run: 25-Year E&S
Sink: B Principal

Start of Run:	30Mar2015, 00:00	Basin Model:	Pond ABC E&S
End of Run:	01Apr2015, 23:00	Meteorologic Model:	25-yr Storm
Compute Time:	28Aug2015, 16:51:25	Control Specifications:	Control 1

Volume Units: IN AC-FT

Computed Results

Peak Discharge:	5.8 (CFS)	Date/Time of Peak Discharge	30Mar2015, 12:55
Volume:	4.6 (AC-FT)		

Summary Results for Sink "B Emergency"

Project: Possum Point Closures Simulation Run: 25-Year E&S
Sink: B Emergency

Start of Run:	30Mar2015, 00:00	Basin Model:	Pond ABC E&S
End of Run:	01Apr2015, 23:00	Meteorologic Model:	25-yr Storm
Compute Time:	28Aug2015, 16:51:25	Control Specifications:	Control 1

Volume Units: IN AC-FT

Computed Results

Peak Discharge:	0.2 (CFS)	Date/Time of Peak Discharge	30Mar2015, 12:55
Volume:	0.0 (AC-FT)		

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HEC-HMS OUTPUT

Sed Basin C: 2-Year, 24-Hour Storm

Summary Results for Reservoir "Sed Pond C"

Project: Possum Point Closures Simulation Run: 2-Year E&S
Reservoir: Sed Pond C

Start of Run:	30Mar2015, 00:00	Basin Model:	Pond ABC E&S
End of Run:	01Apr2015, 23:00	Meteorologic Model:	2-yr Storm
Compute Time:	28Aug2015, 16:48:35	Control Specifications:	Control 1

Volume Units: ○ IN ◉ AC-FT

Computed Results

Peak Inflow:	17.5 (CFS)	Date/Time of Peak Inflow:	30Mar2015, 11:57
Peak Discharge:	2.9 (CFS)	Date/Time of Peak Discharge:	30Mar2015, 12:17
Inflow Volume:	1.0 (AC-FT)	Peak Storage:	2.4 (AC-FT)
Discharge Volume:	1.0 (AC-FT)	Peak Elevation:	13.3 (FT)

Summary Results for Sink "C Principal"

Project: Possum Point Closures Simulation Run: 2-Year E&S
Sink: C Principal

Start of Run:	30Mar2015, 00:00	Basin Model:	Pond ABC E&S
End of Run:	01Apr2015, 23:00	Meteorologic Model:	2-yr Storm
Compute Time:	28Aug2015, 16:48:35	Control Specifications:	Control 1

Volume Units: ○ IN ◉ AC-FT

Computed Results

Peak Discharge:	2.9 (CFS)	Date/Time of Peak Discharge	30Mar2015, 12:17
Volume:	1.0 (AC-FT)		

Summary Results for Sink "C Emergency"

Project: Possum Point Closures Simulation Run: 2-Year E&S
Sink: C Emergency

Start of Run:	30Mar2015, 00:00	Basin Model:	Pond ABC E&S
End of Run:	01Apr2015, 23:00	Meteorologic Model:	2-yr Storm
Compute Time:	28Aug2015, 16:48:35	Control Specifications:	Control 1

Volume Units: ○ IN ◉ AC-FT

Computed Results

Peak Discharge:	0.0 (CFS)	Date/Time of Peak Discharge	30Mar2015, 00:00
Volume:	0.0 (AC-FT)		

C150132.00 **ATTACHMENT 3** 8/26/2015

HEC-HMS OUTPUT

Sed Basin C: 25-Year, 24-Hour Storm

Summary Results for Reservoir "Sed Pond C"

Project: Possum Point Closures Simulation Run: 25-Year E&S
Reservoir: Sed Pond C

Start of Run:	30Mar2015, 00:00	Basin Model:	Pond ABC E&S
End of Run:	01Apr2015, 23:00	Meteorologic Model:	25-yr Storm
Compute Time:	28Aug2015, 16:51:25	Control Specifications:	Control 1

Volume Units: IN AC-FT

Computed Results

Peak Inflow:	59.6 (CFS)	Date/Time of Peak Inflow:	30Mar2015, 11:58
Peak Discharge:	5.8 (CFS)	Date/Time of Peak Discharge:	30Mar2015, 12:32
Inflow Volume:	3.4 (AC-FT)	Peak Storage:	3.5 (AC-FT)
Discharge Volume:	3.4 (AC-FT)	Peak Elevation:	14.1 (FT)

Summary Results for Sink "C Principal"

Project: Possum Point Closures Simulation Run: 25-Year E&S
Sink: C Principal

Start of Run:	30Mar2015, 00:00	Basin Model:	Pond ABC E&S
End of Run:	01Apr2015, 23:00	Meteorologic Model:	25-yr Storm
Compute Time:	28Aug2015, 16:51:25	Control Specifications:	Control 1

Volume Units: IN AC-FT

Computed Results

Peak Discharge:	5.8 (CFS)	Date/Time of Peak Discharge	30Mar2015, 12:32
Volume:	3.4 (AC-FT)		

Summary Results for Sink "C Emergency"

Project: Possum Point Closures Simulation Run: 25-Year E&S
Sink: C Emergency

Start of Run:	30Mar2015, 00:00	Basin Model:	Pond ABC E&S
End of Run:	01Apr2015, 23:00	Meteorologic Model:	25-yr Storm
Compute Time:	28Aug2015, 16:51:25	Control Specifications:	Control 1

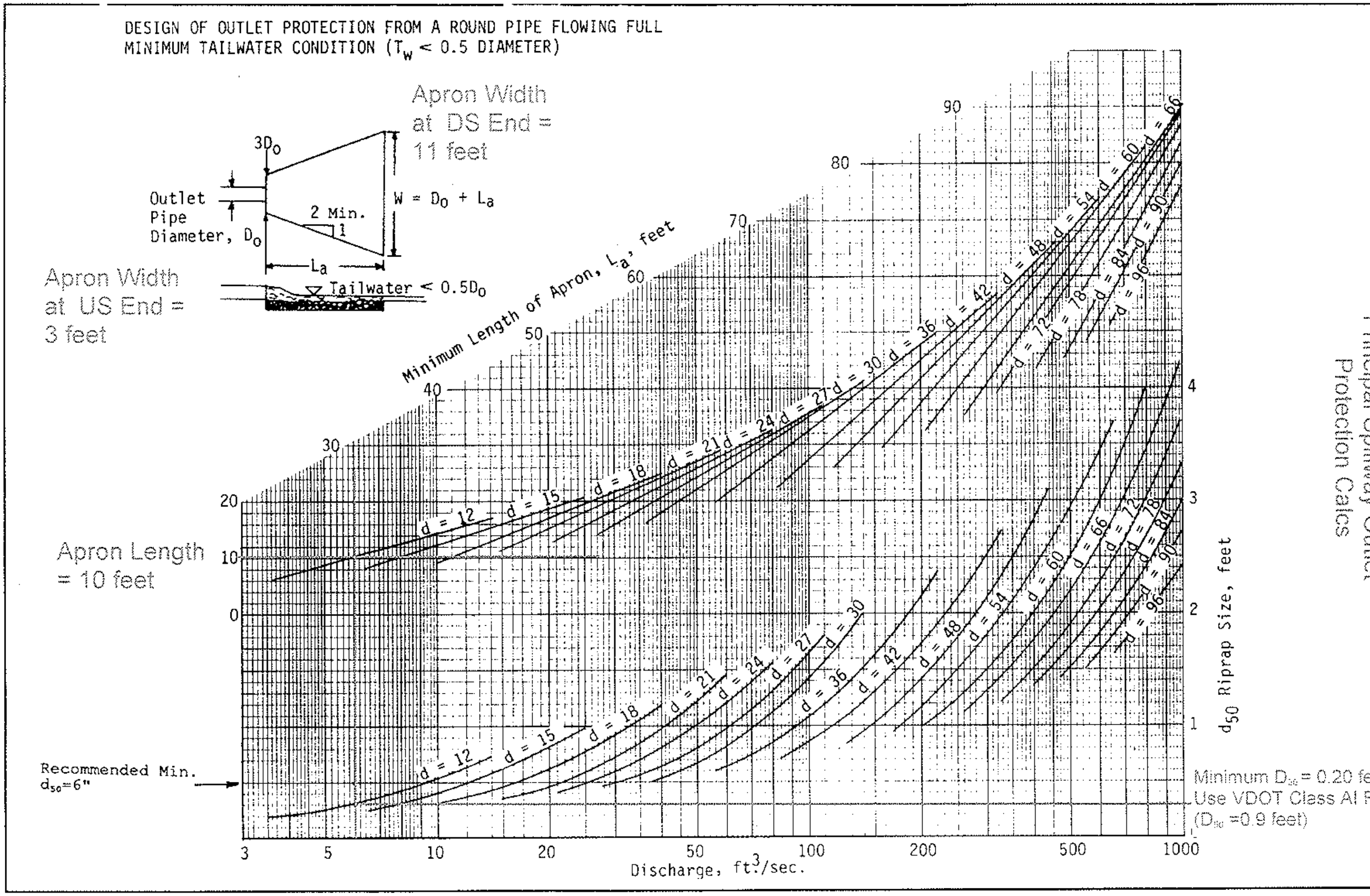
Volume Units: IN AC-FT

Computed Results

Peak Discharge:	0.3 (CFS)	Date/Time of Peak Discharge	30Mar2015, 12:32
Volume:	0.0 (AC-FT)		

ATTACHMENT 4

OUTLET PROTECTION CALCULATIONS



Source: USDA-SCS

III - 164

Plate 3.18-3

1992

3.18

Attachment 4:
Principal Spillway Outlet
Protection Calcs

TABLE 3.19-B

GRADED RIPRAP - DESIGN VALUES

Riprap Class	D_{15} Weight (lbs.)	Mean D_{15} Spherical Diameter (ft.)	Mean D_{50} Spherical Diameter (ft.)
Class AI	25	0.7	0.9
Class I	50	0.8	1.1
Class II	150	1.3	1.6
Class III	500	1.9	2.2
Type I	1,500	2.6	2.8
Type II	6,000	4.0	4.5

Principal Spillway
Emergency Spillway

Source: VDOT Drainage Manual

The designer, after determining the riprap size that will be stable under the flow conditions, shall consider that size to be a minimum size and then, based on riprap gradations actually available in the area, select the size or sizes that equal or exceed the minimum size. The possibility of damage by children shall be considered in selecting a riprap size, especially if there is nearby water or a gully in which to toss the stones.

Thickness

The minimum thickness of the riprap layer shall be 2 times the maximum stone diameter, but not less than 6 inches.

Quality of Stone

Stone for riprap shall consist of field stone or rough unhewn quarry stone of approximately rectangular shape. The stone shall be hard and angular and of such quality that it will not disintegrate on exposure to water or weathering and it shall be suitable in all respects for the purpose intended. The specific gravity of the individual stones shall be at least 2.5.

Rubble concrete may be used provided it has a density of at least 150 pounds per cubic foot, and otherwise meets the requirement of this standard and specification.

ATTACHMENT 5

FILTER DIAPHRAGM CALCULATIONS

SUBJECT:	Possum Point CCR Pond Closures - Sediment Basin B				
By:	SCHELAB	Date:	10/9/2015	Project No.	C150132.00
Chkd By:	BERKEME	Date:	10/14/2015	Sheet No.	

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Filter Diaphragm Design

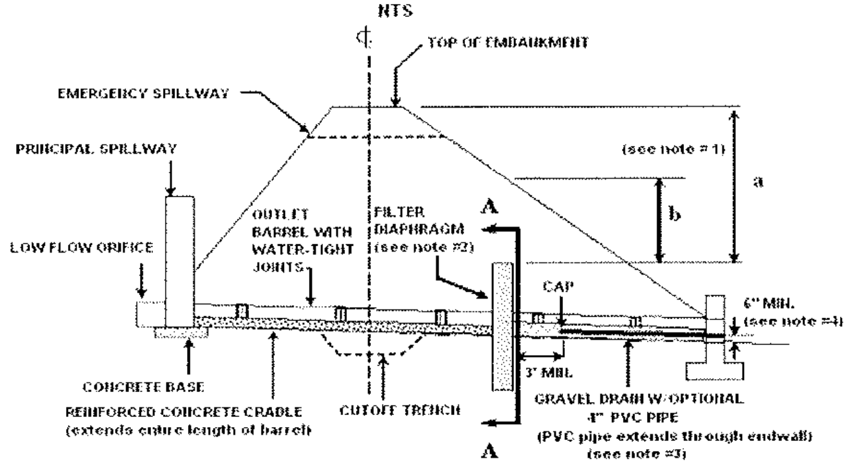
References:

1) United States Department of Agriculture (USDA), Soil Conservation Service, Dimensioning of Filter-Drainage Diaphragms for Conduits According to TR-60", April 1985

2) United States Department of Agriculture (USDA), Soil Conservation Service, Supplement to Dimensioning of Filter-Drainage Diaphragms for Conduits According to TR-60", April 1985

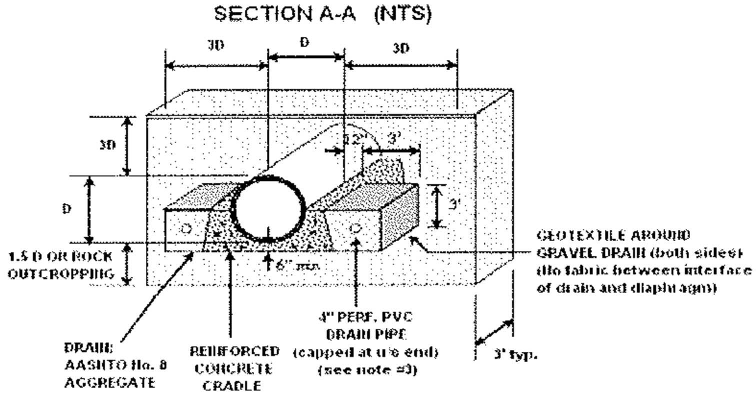
3) National Engineering Handbook (NEH), Part 628 Dams, Chapter 45-Filter Diaphraghms, January 2007.

The following Figure, taken from the Pennsylvania Department of Environmental Protection "Erosion and Sediment Pollution Control Program Manual", March 2012 illustrates the criteria outlined in the above publications.



Notes:
1. Diaphragm should be located d/s of embankment centerline and cutoff trench and u/s of a point where b = 0.5 a
2. Diaphragm should be constructed using a specially graded sand (Typically Type A concrete sand)
3. Optional drin pipe should have maximum 3/16" perforations if used in AASHTO No. 8 drain.
4. Outlet of drain should be located at least 6" above invert of outlet conduit.

SECTION A-A (NTS)



SUBJECT:	Possum Point CCR Pond Closures - Sediment Basin B				
By:	SCHELAB	Date:	10/9/2015	Project No.	C150132.00
Chkd By:	BERKEME	Date:	10/14/2015	Sheet No.	

Based on the above guidance, the following dimensions were selected for design

Conduit Diameter, D =	1 ft
Outside Diameter, Do =	1.00 ft
3Do =	3 ft
Top of Embankment Elevation =	18 ft
Invert of Principal Spillway Barrel at Section A-A=	10.3 ft
Top of Diaphragm at Section A-A=	14.3 ft
a=	3.7 ft
b min =	1.85 ft
b=	3.7 ft

(b is estimated from profile drawing)

TR-60 criteria states that b must be greater than or equal to 0.5a, so the diaphragm location meets the criteria.

Filter Diaphragm Outlet Design-Follows Example 2 From Reference 2

Find: Area of drain outlet

Construct Phreatic Line by Casagrande method

Top of Embankment Elevation (Settled), TE =	18 ft
Top of Diaphragm El., TD=	14.30 ft
Emergency Spillway Crest El., ES =	14 ft
Principal Spillway Crest El., PS =	13 ft
Toe of Upstream Embankment, TU =	10 ft
Outlet Channel El., OC =	10 ft
Embankment Side Slope (Upstream Side), Z1 =	3.0:1
Embankment Side Slope (Downstream Side), Z2 =	3:01
Embankment Top Width (Settled), TW =	36 ft

m is the distance from where water surface intersects the slope to the toe of the embankment

1. 0.33m= 1/3 * [(PS-TU)*3] =	3 ft
m =	9 ft
2. d (estimated from plan view drawing)	64 ft
3. hy = PS-OC =	3.0 ft
4. Yo= (hy^2 +d^2)^0.5 - d =	0.07 ft

SUBJECT:	Possum Point CCR Pond Closures - Sediment Basin B				
By:	SCHELAB	Date:	10/9/2015	Project No.	C150132.00
Chkd By:	BERKEME	Date:	10/14/2015	Sheet No.	

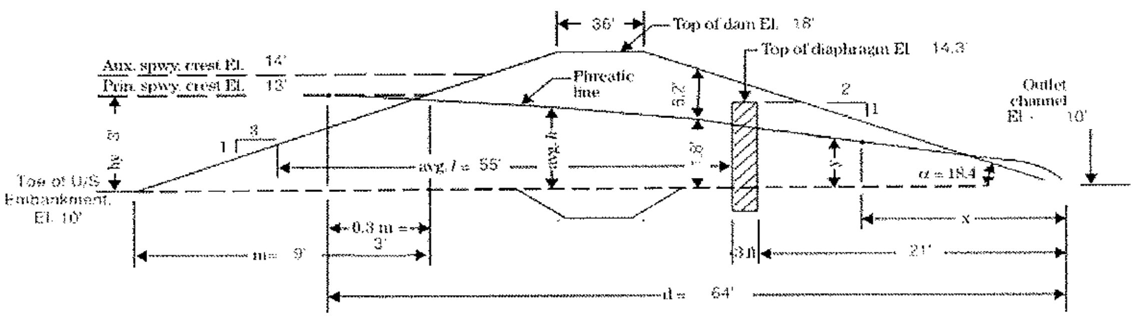
5. Calculate values of y corresponding to various values of x.

y=(2Yox + Yo^2)^0.5

x	y
10	1.2
21	1.7
24	1.8
64	3.0

6. Plot basic parabola as the phreatic line of the structure layout

Figure 45C–5 Structure layout and phreatic line computation



(210-VI-NEH, January 2007) 45C–7

Calculate Design Q for Filter Diaphragm

Use Darcy's Law, Q=KiA

1. Seepage Zone eqauls average height under phreatic line times width of diaphragm

Width of Diaphragm, W = 7 ft

A = (1.8+3.0)/2 x W = 17 sq ft

2. Hydraulic gradient, i=h/l

h = difference between emergency spillway and the height where the phreatic line hits the upstream face of the diaphragm.

h= ES- (OC + 1.8) = 2.2 ft

l= average seepage flow path from midpoint between the upstream toe of the embankment to the principal spillway crest, horizontally to the face of the diaphragm.

l= 55 ft (measured from drawing)

i= h/l = 0.039

3. Permeability coefficeint, K

K= 1 ft/day (taken from Ref 2, example 2)

For conservatism, assume embankment permeability is 100 times actual estimated permeability (0.01 ft/day)

SUBJECT:	Possum Point CCR Pond Closures - Sediment Basin B				
By:	SCHELAB	Date:	10/9/2015	Project No.	C150132.00
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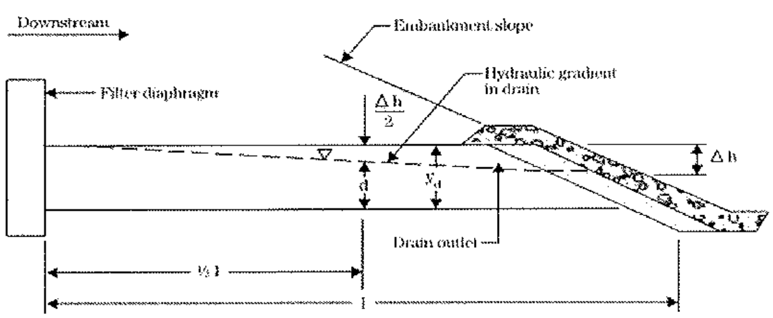
4. Design Q using Darcy's Law

Q=KiA= 0.7 cf/day

Calculate area of outlet for Filter Diaphragm

1. Consider the height of the drain as the height corresponding to the area calculated by Darcy's Law plus half of the hydraulic gradient in the drain.

Figure 45C–7 Filter diaphragm to the downstream toe

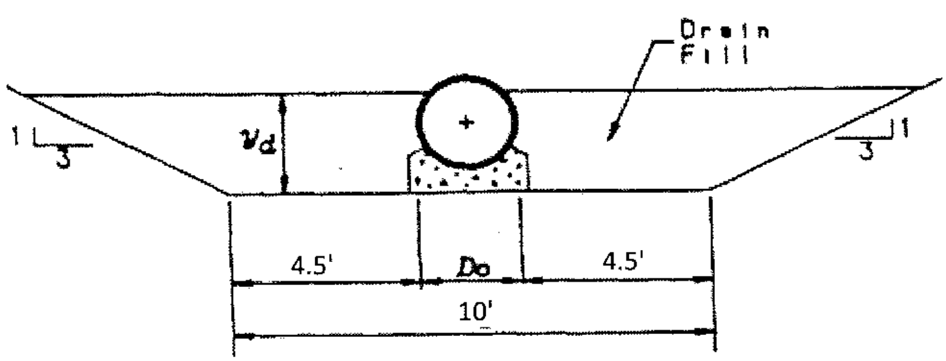


(210–VI–NEH, January 2007)

2. Calculate the average flow area of the drain outlet by Darcy's Law

GIVEN:

Q =	0.7 cf/day		
i=h/l = h/21			
l=	21		
Kf for drain outlet =	20 ft/day (From Reference 2 example)		
Q=KiA, A=Q/Kfi =	0.03 /i		
		a	3
yd=d+h/2		b	9
3d^2 + 9 d - A = 0	to solve quadratic equation:	c	A



OUTLET FOR DIAPHRAGM

SUBJECT:	Possum Point CCR Pond Closures - Sediment Basin B				
By:	SCHELAB	Date:	10/9/2015	Project No.	C150132.00
Chkd By:	BERKEME	Date:	10/14/2015	Sheet No.	

Test several h to find minimum Yd

h	i=h/21	A=.03/i		d1	d2	Yd
0.3	0.0143	2	108.96	0.24	-3.24	0.39
0.4	**0.0190**	**2**	**101.97**	**0.18**	**-3.18**	**0.38**
0.5	0.0238	1	97.77	0.15	-3.15	0.40
1.0	0.0476	1	89.39	0.08	-3.08	0.58
2.0	0.0952	0	85.19	0.04	-3.04	1.04
3.0	0.1429	0	83.80	0.03	-3.03	1.53
3.5	0.1667	0	83.40	0.02	-3.02	1.77
4.0	0.1905	0	83.10	0.02	-3.02	2.02

Use Yd= 0.40 ft

3. Area of drain outlet

A=3Yd^2+9Yd= 4.1 ft^2

SUBJECT POSSUM POINT CCR POND CLOSURES
SEDIMENTATION BASIN DESIGN – BASIN E-1

BY SCHELAB DATE 8/23/2015 PROJ. NO. C150132.00

CHKD. BY BERKEME DATE 8/24/2015

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INTRODUCTION

This calculation will size a proposed temporary sedimentation basin and associated outlet structures in Pond E for sediment control during construction. Storage and discharge requirements are based on Virginia Erosion and Sedimentation Control (E&S) handbook.

REFERENCES

1. Virginia Erosion and Sedimentation Control Handbook, Virginia Department of Environmental Quality, 1992.
2. Site Hydrology Calculations (included in this calculation package).
3. Subgrade Plan for Pond E
4. Technical Manual: Overtopping Protection for Dams, Chapter 8, Federal Emergency Management Agency, May 2014

ATTACHMENTS

1. Pond Pack Spillway Rating Curves
2. HEC-HMS Input
3. HEC-HMS Output
4. Erosion Protection Calculations
5. Filter Diaphragm Calculations

STORAGE REQUIRED

From the Virginia E&S Regulations, the following storage criteria are utilized for the Sedimentation Basin:

- Capacity of at least 134 cubic yards per contributing acre
- 67 cubic yards per acre is to be permanent pool
- 67 cubic yards is to be drawdown area
- Sediment cleanout shall occur when wet storage is reduced to 34 cubic yards per acre (sediment occupies 33 cubic yards per acre)

SUBJECT POSSUM POINT CCR POND CLOSURES
SEDIMENTATION BASIN DESIGN – BASIN E-1

BY SCHELAB DATE 8/23/2015 PROJ. NO. C150132.00

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Storage Required continued

The Sedimentation Basin will be utilized once CCB material has been completely removed from Pond E and CCB material has been covered with a soil cap in Pond D, thus runoff will only contain soil particles and not CCB material.

231 acres total draining to the Sediment Pond (Reference 2)
67 cy per watershed acre of wet volume yields
15,477 cy wet volume required
9.59 acre-feet wet volume required

67 cy per watershed acre of dry volume yields
15,477 cy dry volume required
9.59 acre-feet dry volume required

33 cy per watershed acre required sediment cleanout volume, maximum
7,623 cy volume at maximum sediment cleanout level
4.73 acre-feet volume at maximum sediment cleanout level

STORAGE PROVIDED

Assess the storage provided in the Sedimentation Basin and establish required wet and dry storage levels. Use average areas between elevations to calculate volume. Surface areas at the index elevations are taken from the subgrade plan for Pond E (Reference 3). Data in italics are interpolated for the given elevation.

Basin Stage Storage

Elevation (ft)	Surface Area (ft^2)	Surface Area (ac)	Incremental Volume (cf)	Incremental Volume (ac-ft)	Total Volume (cf)	Total Volume (ac-ft)	
4	68,820	1.58		0.00	0	0.00	
5.8	*161,306*	*3.70*	*207,113*	*4.75*	*207,113*	*4.75*	*<--- Sediment Cleanout Elev.*
6	171,582	3.94	33,289	0.76	240,402	5.52	
7.5	*184,105*	*4.23*	*266,765*	*6.12*	*507,167*	*11.64*	*<--- Wet Volume Elev. (Orifice Invert)*
8	188,279	4.32	93,096	2.14	600,263	13.78	
9.7	*205,727*	*4.72*	*334,905*	*7.69*	*935,168*	*21.47*	*<--- Dry Volume Elev. (Riser Crest)*
10	208,806	4.79	62,180	1.43	997,348	22.90	
11.0	*258,592*	*5.94*	*233,699*	*5.36*	*1,231,047*	*28.26*	*<--- Emergency Spillway Crest Elev.*
12	308,377	7.08	283,484	6.51	1,514,531	34.77	
13.5	*379,598*	*8.71*	*515,981*	*11.85*	*2,030,512*	*46.61*	*<--- Basin Embankment Crest Elev.*
14	403,338	9.26	195,734	4.49	2,226,246	51.11	

DISCHARGE REQUIREMENTS

From the Virginia E&S Regulations, the principal and emergency spillways must meet the following:

- The principal spillway must pass the peak flow from a 2-year 24-hour storm;
- The two spillways combined must be capable of discharging the peak flow from a 25-year 24-hour storm with a minimum freeboard of one foot;
- The principal spillway riser crest must be a minimum of one foot below the emergency spillway crest.

The Spillway Will Consist of:

- 4.0-foot diameter High Density Polyethylene (HDPE) pipe used as a riser (crest elevation 9.7 feet)
- 2-foot diameter HDPE pipe used as a barrel
  (Upstream Invert = 7.5 feet, Downstream Invert = 7.0 feet)
- Trapezoidal emergency spillway with a 20-foot bottom width and 6:1 side slopes (to facilitate driving around the pond embankment). Crest elevation is 11.0 (1.3 feet above the principal spillway crest).The spillway will be constructed of fabric formed concrete to provide a stable driving surface and reduce the change of erosion.

HYDRAULIC ANALYSIS

Rating curves for the spillway structures identified above are developed using the composite outlet structures feature of Pond Pack Version 8i (Attachment 1). The rating curves are then input into the HEC-HMS developed model for the site (Site Hydrology Calculations).

The 2-year and 100-year storms are routed through the Sedimentation Basin for two conditions of site development:

1. Pond E construction site is fully disturbed and Pond D water is diverted to treatment.
2. Pond E construction site is fully vegetated and Pond D water (fully disturbed condition) is drained into the Sediment Basin.

SUBJECT POSSUM POINT CCR POND CLOSURES
SEDIMENTATION BASIN DESIGN – BASIN E-1

BY SCHELAB DATE 8/23/2015 PROJ. NO. C150132.00

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Hydraulic Analysis continued

HEC-HMS output data is included as Attachment 2. The worst case condition for the sediment basin is Condition 2, which contributed to the following peak discharge and peak elevation:

- Peak 2-year Basin Elevation = 10.6 feet
  2-year storm controlled by principal spillway
- Peak 25-year Basin Elevation = 12.5 feet
  More than 1 ft of freeboard provided (crest = 13.5 feet)
- Peak 25-year Principal Spillway Discharge = 28.9 cfs
- Peak 25-year Emergency Spillway Discharge = 154.8 cfs

ADDITIONAL DESIGN FEATURES

Length to Width Ratio

The Virginia E&S Regulations dictate that "the effective flow length must be twice the effective flow width." The lateral dimensions of the Sedimentation Pond are:

W, Width = approximately 450 feet (average)

Three channels are proposed to discharge to the Sedimentation Pond, thus each will be required to have a flow Length of 2W, or 900 feet. Baffles will be designed giving the following flow lengths:

Flow Length E-3 with Baffle = 1,048 feet
Length/Width ratio = 2.3, which is acceptable

Flow Length E-2 with Baffle = 880 feet
Length/Width ratio = 2.0, which is acceptable

Flow Length E-1 = 903 feet
Length/Width ratio = 2.0, which is acceptable

SUBJECT POSSUM POINT CCR POND CLOSURES
SEDIMENTATION BASIN DESIGN – BASIN E-1

BY SCHELAB DATE 8/23/2015 PROJ. NO. C150132.00

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Principal Spillway Outlet Protection

Outlet protection for the 24-inch principal spillway barrel is sized to protect against erosion for the 25-year storm based on Sections 3.18 (Outlet Protection) and 3.19 (Riprap) of the VA E&S manual. Refer to Attachment 3 for apron sizing. The apron should be installed per VDOT installation guidelines. The following apron dimensions are selected for design:

Riprap D_{50}	**=**	**1.1 feet (VDOT Class I)**
Length	**=**	**18 feet**
Upstream Width	**=**	**6 feet**
Downstream Width	**=**	**20 feet**

Emergency Spillway Erosion Protection

Embankment erosion protection is provided downstream of the fabric form concrete emergency spillway section. Design guidance is provided in Reference 4, and includes the following equations for slopes between 17% and 40%:

$$q_a = K_3 S_t^{-0.58} D_{50}^{1.89} \qquad 0.167 \le S_t \le 0.4 \qquad \textbf{Eq. 8-2}$$

$$D_{50} = K_4 q_a^{0.53} S_t^{0.307}$$

Where:

q_a = allowable or design unit discharge, above which riprap failure is expected ($ft^3/s/ft$)

S_t = the embankment slope expressed as the tangent of the slope angle (i.e., for 2:1 slope, S_t=0.5)

D_{50} = the riprap diameter for which 50 percent by weight of the material is finer (ft m)

Robinson et al. (1998)	K_3	4.3
	K_4	0.462

25-year flow through the spillway is estimated to be approximately 155 cfs. This equates to 7.75 cfs/s/ft (q_a).

The embankment slope (S_t) = 0.33 ft/ft

Applying Equation 8.2, the **Minimum D_{50} = 0.98 ft**

Use VDOT Class I Riprap (D_{50} = 1.1 ft)

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SUBJECT POSSUM POINT CCR POND CLOSURES
SEDIMENTATION BASIN DESIGN – BASIN E-1

BY SCHELAB DATE 8/23/2015 PROJ. NO. C150132.00

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DEWATERING

Virginia E&S Regulations state that the dewatering orifice must dewater the dry storage volume in a minimum of 6 hours. From the regulations:

A = flow area of orifice, in square feet

d = diameter of circular orifice, in feet

h = average driving head (maximum possible head measured from radius of orifice to crest of principal spillway divided by 2), in feet

Q = volumetric flowrate through orifice needed to achieve approximate 6-hour drawdown, cubic feet per second

S = total storage available in dry storage area, cubic feet

Q = S / 21,600 seconds

Use S for basin and find Q. Then substitute in calculated Q and find A:

$$A = \frac{Q}{\left(64.32 \; x \; h\right)^{\frac{1}{2}} (0.6)}$$

Then, substitute in calculated A and find d:

$$d* = 2 \; x \left(\frac{A}{3.14}\right)^{\frac{1}{2}}$$

The Temporary Sediment Basin in Pond E-1 is designed to dewater in 24-hours.

SUBJECT POSSUM POINT CCR POND CLOSURES
SEDIMENTATION BASIN DESIGN – BASIN E-1

BY SCHELAB DATE 10/8/2015 PROJ. NO. C150132.00

CHKD. BY BERKEME DATE 10/8/2015

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Dewatering continued

S = dry storage available =	9.83	acre-feet
Volume at riser crest =	21.47	acre-feet
S = 428,195 cubic feet		
Use drawdown of 24 hours =	86,400	sec
Q = S / 86,400 seconds =	5.0	cfs
Invert elevation of orifice =	7.5	
Riser crest elevation =	9.7	
Average head =	1.10	feet
Orifice Diameter =	8.00	inches
Orifice Area =	0.35	sf
Number of Orifices =	3	
Flow Provided =	5.3	cfs

ANTI-SEEP COLLARS

Determine the Length of the Barrel within the saturated zone:

$$L_s = Y(Z + 4)\left(1 + \frac{S}{0.25 - S}\right)$$

where:

L_s = length of barrel in the saturated zone, feet

Y = the depth of water at the principal spillway crest, feet

Z = slope of the upstream face of embankment in Z feet horizontal to one vertical

S = slope of the barrel in feet per foot

Y = 2.2 ft
Z = 3
S = .005 ft/ft
L_s = 16 ft
L_f = 1.1 x Ls = 17.6 ft
Assume 2 Collars will be used
V_{min} = 0.1 x Ls / 4 = 0.4 ft (use 2')
Spacing = 14 x V_{min} = 5.6 ft (use 6')

FILTER DIAPHRAGMS

Filter diaphragms may be used in lieu of Anti-Seep Collars. Refer to attached Filter Diaphragm calculation.

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SUBJECT POSSUM POINT CCR POND CLOSURES
SEDIMENTATION BASIN DESIGN – BASIN E-1

BY SCHELAB DATE 8/23/2015 PROJ. NO. C150132.00

CHKD. BY BERKEME DATE 8/24/2015

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ATTACHMENT 1

POND PACK SPILLWAY RATING CURVES

Composite Outlet Structure Detailed Report: E-1 Principal Spillway

Element Details			
Label	E-1 Principal Spillway	Notes	

Headwater Range			
Headwater Type	User Defined Headwater	Increment (Headwater)	0.50 ft
Minimum (Headwater)	4.00 ft	Maximum (Headwater)	14.00 ft

SpotElevation (ft)

Tailwater Setup	
Tailwater Type	Free Outfall

Tailwater Tolerances			
Maximum Iterations	30	Tailwater Tolerance (Maximum)	0.50 ft
Headwater Tolerance (Minimum)	0.01 ft	Flow Tolerance (Minimum)	0.001 ft³/s
Headwater Tolerance (Maximum)	0.50 ft	Flow Tolerance (Maximum)	10.000 ft³/s
Tailwater Tolerance (Minimum)	0.01 ft		

Outlet Structure	
Outlet Structure Type	Riser

Outlet Structure (IDs and Direction)			
Outlet ID	Riser - 1	Downstream ID	Culvert - 1
Flow Direction	Forward and Reverse Flow	Notes	

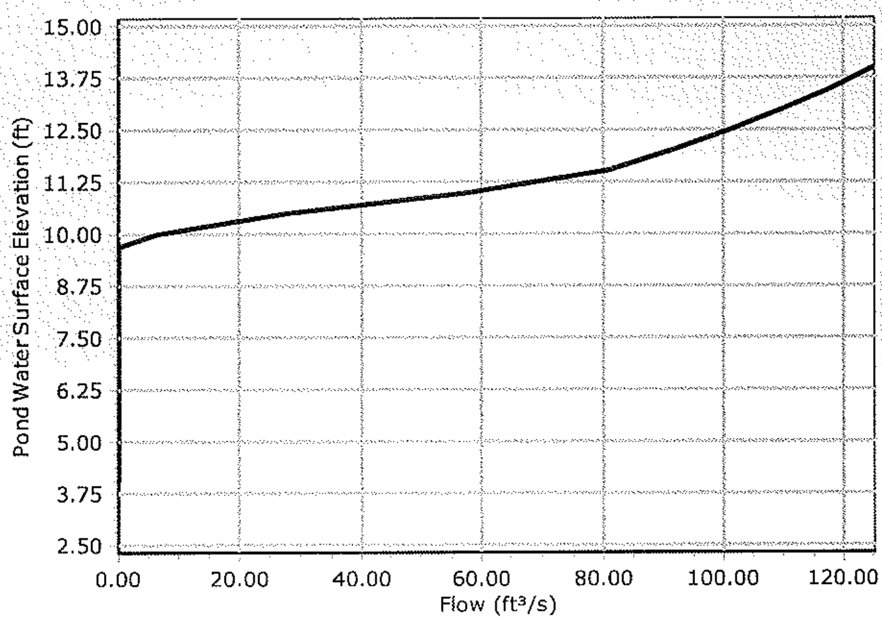
Outlet Structure (Advanced)			
Elevation (On)	0.00 ft	Elevation (Off)	0.00 ft

Outlet Structure (Riser)			
Riser	Stand Pipe	Transition Elevation	0.00 ft
Diameter	48.0 in	Transition Height	0.00 ft
Weir Coefficient	3.10 (ft^0.5)/s	K Reverse	1.000
Orifice Coefficient	0.600		

Outlet Structure (Common)	
Elevation	9.70 ft

Outlet Structure (Riser, Advanced)			
Use Orifice Depth to Crest?	True	Use Submerged Weir Equation?	False

Composite Outlet Structure Detailed Report: E-1 Principal Spillway



RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Riser - 1 (Stand Pipe)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft^3/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)
4.00	0.00	0.00	0.00	0.00
4.50	0.00	0.00	0.00	0.00
5.00	0.00	0.00	0.00	0.00
5.50	0.00	0.00	0.00	0.00
6.00	0.00	0.00	0.00	0.00
6.50	0.00	0.00	0.00	0.00
7.00	0.00	0.00	0.00	0.00
7.50	0.00	0.00	0.00	0.00
8.00	0.00	0.00	0.00	0.00
8.50	0.00	0.00	0.00	0.00
9.00	0.00	0.00	0.00	0.00
9.50	0.00	0.00	0.00	0.00
9.70	0.00	0.00	0.00	0.00
10.00	6.40	10.00	Free Outfall	8.91
10.50	27.87	10.50	10.50	10.50
11.00	57.74	11.00	11.00	11.00
11.50	81.15	11.50	11.50	11.50

Composite Outlet Structure Detailed Report: E-1 Principal Spillway

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Riser - 1 (Stand Pipe)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft^3/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)
12.00	91.73	12.00	12.00	12.00
12.50	101.21	12.50	12.50	12.50
13.00	109.87	13.00	13.00	13.00
13.50	117.90	13.50	13.50	13.50
14.00	125.42	14.00	14.00	14.00

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft^3/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00

Message
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.

Composite Outlet Structure Detailed Report: E-1 Principal Spillway

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Riser - 1 (Stand Pipe)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Message
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
Weir: H =0.3ft
FULLY CHARGED RISER: ADJUSTED TO WEIR: H =0.8ft
FULLY CHARGED RISER, DOWNSTREAM CONTROL: Kev=0. Hev=0.000
FULLY CHARGED RISER, DOWNSTREAM CONTROL: Kev=0. Hev=0.000
FULLY CHARGED RISER, DOWNSTREAM CONTROL: Kev=0. Hev=0.000
FULLY CHARGED RISER, DOWNSTREAM CONTROL: Kev=0. Hev=0.000
FULLY CHARGED RISER, DOWNSTREAM CONTROL: Kev=0. Hev=0.000
FULLY CHARGED RISER, DOWNSTREAM CONTROL: Kev=0. Hev=0.000
FULLY CHARGED RISER, DOWNSTREAM CONTROL: Kev=0. Hev=0.000

Outlet Structure

Outlet Structure Type	Culvert	Culvert Type	Circular

Outlet Structure (IDs and Direction)

Outlet ID	Culvert - 1	Downstream ID	Tailwater
Flow Direction	Forward and Reverse Flow	Notes	

Outlet Structure (Advanced)

Elevation (On)	0.00 ft	Elevation (Off)	0.00 ft

Culvert Data

Number of Barrels	1	Downstream Invert	7.00 ft
Length	100.00 ft	Diameter	24.0 in
Upstream Invert	7.50 ft		

Composite Outlet Structure Detailed Report: E-1 Principal Spillway

Culvert Data

Unsubmerged->Submerged

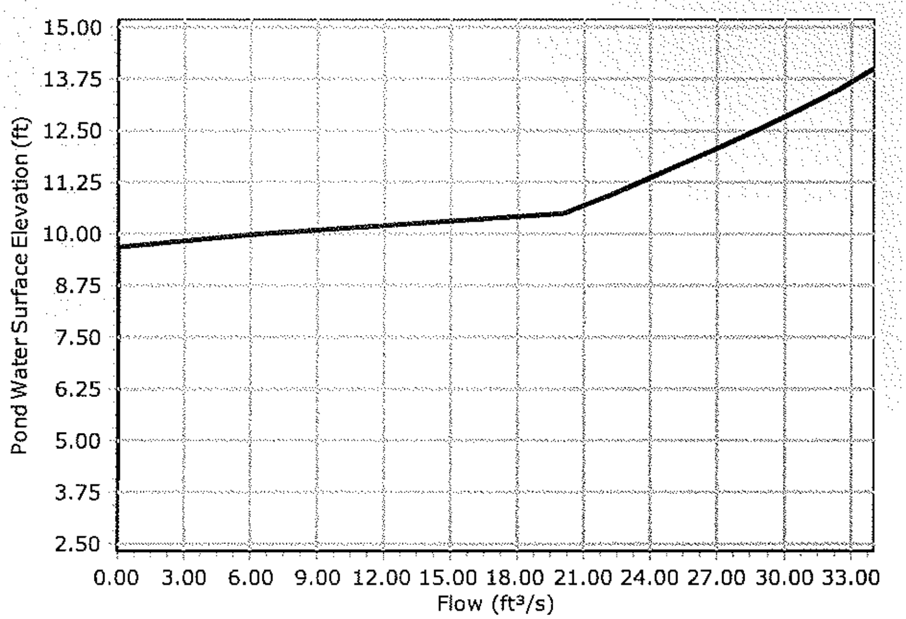
Specify Transitions	False	Compute Inlet Control Only	False

Culvert Coefficients

Inlet Description	Concrete - Square edge w/headwall	C	0.0398
Chart	Chart 1	Y	0.6700
Nomograph	Nomograph 1	Manning's n	0.013
Equation Form	Form 1	Ke	0.500
K	0.0098	Kr	0.000
M	2.0000	Slope Correction Factor	-0.500

Culvert (Advanced)

Convergence Tolerance	0.00 ft	Specify Number of Backwater Sections	False



Composite Outlet Structure Detailed Report: E-1 Principal Spillway

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Culvert - 1 (Culvert-Circular)

Mannings open channel maximum capacity: 17.21 ft³/s
Upstream ID = Riser - 1 (Stand Pipe)
Downstream ID = Tailwater (Pond Outfall)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)
4.00	0.00	0.00	0.00	Free Outfall
4.50	0.00	0.00	0.00	Free Outfall
5.00	0.00	0.00	0.00	Free Outfall
5.50	0.00	0.00	0.00	Free Outfall
6.00	0.00	0.00	0.00	Free Outfall
6.50	0.00	0.00	0.00	Free Outfall
7.00	0.00	0.00	0.00	Free Outfall
7.50	0.00	0.00	0.00	Free Outfall
8.00	0.00	0.00	0.00	Free Outfall
8.50	0.00	0.00	0.00	Free Outfall
9.00	0.00	0.00	0.00	Free Outfall
9.50	0.00	0.00	0.00	Free Outfall
9.70	0.00	0.00	0.00	Free Outfall
10.00	6.41	8.91	Free Outfall	Free Outfall
10.50	20.08	10.50	Free Outfall	Free Outfall
11.00	22.38	11.00	Free Outfall	Free Outfall
11.50	24.62	11.50	Free Outfall	Free Outfall
12.00	26.74	12.00	Free Outfall	Free Outfall
12.50	28.74	12.50	Free Outfall	Free Outfall
13.00	30.63	13.00	Free Outfall	Free Outfall
13.50	32.42	13.50	Free Outfall	Free Outfall
14.00	34.12	14.00	Free Outfall	Free Outfall

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.01	(N/A)	0.00
0.00	7.79	(N/A)	0.00

Composite Outlet Structure Detailed Report: E-1 Principal Spillway

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Culvert - 1 (Culvert-Circular)

Mannings open channel maximum capacity: 17.21 ft³/s
Upstream ID = Riser - 1 (Stand Pipe)
Downstream ID = Tailwater (Pond Outfall)

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
0.00	35.36	(N/A)	0.00
0.00	56.53	(N/A)	0.00
0.00	64.98	(N/A)	0.00
0.00	72.46	(N/A)	0.00
0.00	79.24	(N/A)	0.00
0.00	85.48	(N/A)	0.00
0.00	91.30	(N/A)	0.00

Message
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
CRIT.DEPTH CONTROL Vh= .343ft Dcr= .896ft CRIT.DEPTH Hev= .00ft
FULL FLOW...Lfull=16.43ft Vh=.635ft HL=1.082ft Hev= .00ft
FULL FLOW...Lfull=66.25ft Vh=.789ft HL=1.832ft Hev= .00ft
FULL FLOW...Lfull=83.17ft Vh=.954ft HL=2.416ft Hev= .00ft
FULL FLOW...Lfull=90.36ft Vh=1.126ft HL=2.952ft Hev= .00ft
FULL FLOW...Lfull=94.06ft Vh=1.301ft HL=3.470ft Hev= .00ft
FULL FLOW...Lfull=96.29ft Vh=1.477ft HL=3.982ft Hev= .00ft
FULL FLOW...Lfull=97.54ft Vh=1.655ft HL=4.487ft Hev= .00ft
FULL FLOW...Lfull=98.68ft Vh=1.833ft HL=4.994ft Hev= .00ft

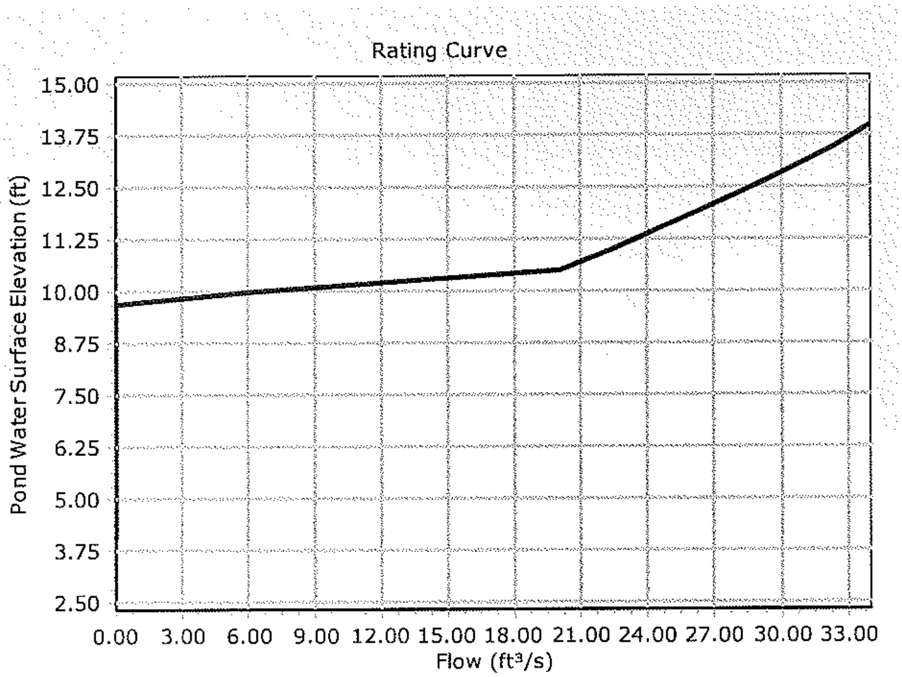
Composite Outlet Structure Detailed Report: E-1 Principal Spillway

Composite Rating Table
Tailwater Elevation = Free Outfall (E-1 Principal Spillway)

Water Surface Elevation (ft)	Flow (ft^3/s)	Tailwater Elevation (ft)	Convergence Error (ft)
4.00	0.00	(N/A)	0.00
4.50	0.00	(N/A)	0.00
5.00	0.00	(N/A)	0.00
5.50	0.00	(N/A)	0.00
6.00	0.00	(N/A)	0.00
6.50	0.00	(N/A)	0.00
7.00	0.00	(N/A)	0.00
7.50	0.00	(N/A)	0.00
8.00	0.00	(N/A)	0.00
8.50	0.00	(N/A)	0.00
9.00	0.00	(N/A)	0.00
9.50	0.00	(N/A)	0.00
9.70	0.00	(N/A)	0.00
10.00	6.41	(N/A)	0.00
10.50	20.08	(N/A)	0.00
11.00	22.38	(N/A)	0.00
11.50	24.62	(N/A)	0.00
12.00	26.74	(N/A)	0.00
12.50	28.74	(N/A)	0.00
13.00	30.63	(N/A)	0.00
13.50	32.42	(N/A)	0.00
14.00	34.12	(N/A)	0.00

Contributing Structures
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
Riser - 1,Culvert - 1
Riser - 1,Culvert - 1
Riser - 1,Culvert - 1
Riser - 1,Culvert - 1
Riser - 1,Culvert - 1
Riser - 1,Culvert - 1
Riser - 1,Culvert - 1
Riser - 1,Culvert - 1
Riser - 1,Culvert - 1

Composite Outlet Structure Detailed Report: E-1 Principal Spillway



Composite Outlet Structure Detailed Report: E-1 Emergency Spillway

Element Details

Label	E-1 Emergency Spillway	Notes	

Headwater Range

Headwater Type	User Defined Headwater	Increment (Headwater)	0.50 ft
Minimum (Headwater)	4.00 ft	Maximum (Headwater)	14.00 ft

SpotElevation (ft)

Tailwater Setup

Tailwater Type	Free Outfall

Tailwater Tolerances

Maximum Iterations	30	Tailwater Tolerance (Maximum)	0.50 ft
Headwater Tolerance (Minimum)	0.01 ft	Flow Tolerance (Minimum)	0.001 ft³/s
Headwater Tolerance (Maximum)	0.50 ft	Flow Tolerance (Maximum)	10.000 ft³/s
Tailwater Tolerance (Minimum)	0.01 ft		

Outlet Structure

Outlet Structure Type	Weir

Outlet Structure (IDs and Direction)

Outlet ID	Weir - 1	Downstream ID	Tailwater
Flow Direction	Forward and Reverse Flow	Notes	

Outlet Structure (Advanced)

Elevation (On)	0.00 ft	Elevation (Off)	0.00 ft

Outlet Structure (Weir)

Weir	Irregular Weir	Weir Coefficient	3.00 (ft^0.5)/s
Vary Coefficient with Depth	False		

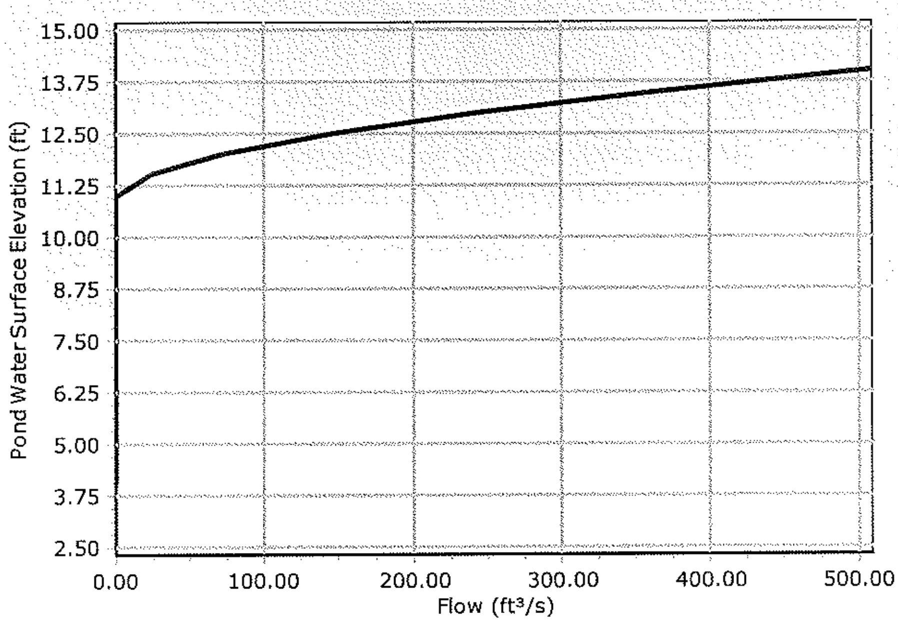
Irregular Weir Cross-section

Station (ft)	Elevation (ft)
0.00	3.00
18.00	0.00
38.00	0.00
56.00	3.00

Composite Outlet Structure Detailed Report: E-1 Emergency Spillway

Outlet Structure (Common)	
Elevation	11.00 ft

Outlet Structure (Weir, Advanced)	
User Defined Table	False



RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Weir - 1 (Irregular Weir)

Upstream ID = (Pond Water Surface)
Downstream ID = Tailwater (Pond Outfall)

Water Surface Elevation (ft)	Flow (ft^3/s)	Tailwater Elevation (ft)	Convergence Error (ft)
4.00	0.00	(N/A)	0.00
4.50	0.00	(N/A)	0.00
5.00	0.00	(N/A)	0.00
5.50	0.00	(N/A)	0.00
6.00	0.00	(N/A)	0.00
6.50	0.00	(N/A)	0.00
7.00	0.00	(N/A)	0.00
7.50	0.00	(N/A)	0.00
8.00	0.00	(N/A)	0.00
8.50	0.00	(N/A)	0.00

Composite Outlet Structure Detailed Report: E-1 Emergency Spillway

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Weir - 1 (Irregular Weir)

Upstream ID = (Pond Water Surface)
Downstream ID = Tailwater (Pond Outfall)

Water Surface Elevation (ft)	Flow (ft^3/s)	Tailwater Elevation (ft)	Convergence Error (ft)
9.00	0.00	(N/A)	0.00
9.50	0.00	(N/A)	0.00
10.00	0.00	(N/A)	0.00
10.50	0.00	(N/A)	0.00
11.00	0.00	(N/A)	0.00
11.50	23.46	(N/A)	0.00
12.00	72.73	(N/A)	0.00
12.50	145.30	(N/A)	0.00
13.00	241.71	(N/A)	0.00
13.50	362.95	(N/A)	0.00
14.00	510.18	(N/A)	0.00

Computation Messages
E < Y min=11.00
E < Y min=11.00
E < Y min=11.00
E < Y min=11.00
E < Y min=11.00
E < Y min=11.00
E < Y min=11.00
E < Y min=11.00
E < Y min=11.00
E < Y min=11.00
E < Y min=11.00
E < Y min=11.00
E < Y min=11.00
E < Y min=11.00
E = Y min=11.00
Max.H=.50; Max.Htw=free out;; W(ft) =26.00
Max.H=1.00; Max.Htw=free out;; W(ft) =32.00
Max.H=1.50; Max.Htw=free out;; W(ft) =38.00
Max.H=2.00; Max.Htw=free out;; W(ft) =44.00
Max.H=2.50; Max.Htw=free out;; W(ft) =50.00
Max.H=3.00; Max.Htw=free out;; W(ft) =56.00

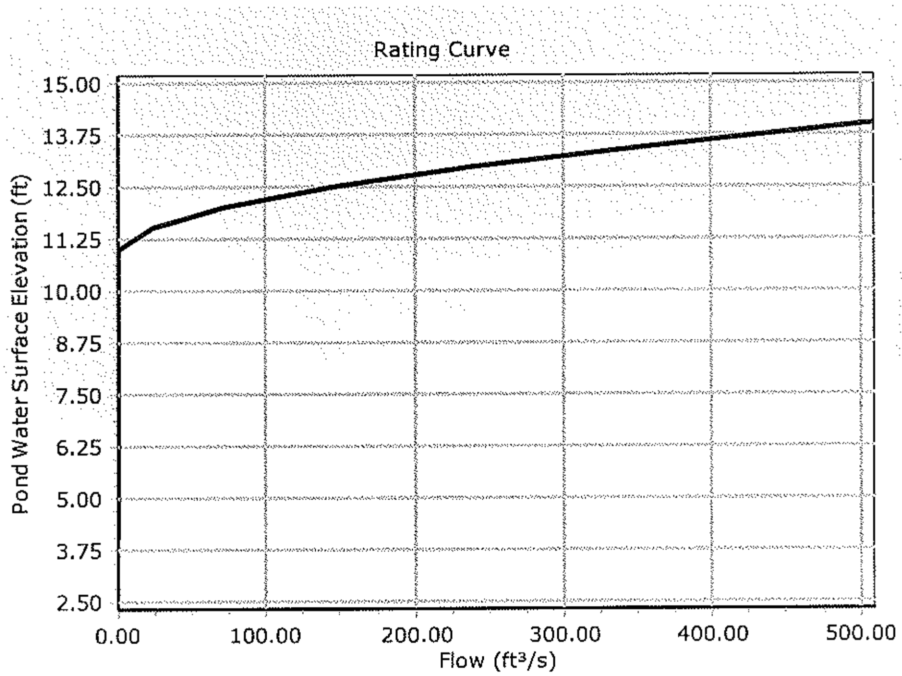
Composite Outlet Structure Detailed Report: E-1 Emergency Spillway

Composite Rating Table
Tailwater Elevation = Free Outfall (E-1 Emergency Spillway)

Water Surface Elevation (ft)	Flow (ft^3/s)	Tailwater Elevation (ft)	Convergence Error (ft)
4.00	0.00	(N/A)	0.00
4.50	0.00	(N/A)	0.00
5.00	0.00	(N/A)	0.00
5.50	0.00	(N/A)	0.00
6.00	0.00	(N/A)	0.00
6.50	0.00	(N/A)	0.00
7.00	0.00	(N/A)	0.00
7.50	0.00	(N/A)	0.00
8.00	0.00	(N/A)	0.00
8.50	0.00	(N/A)	0.00
9.00	0.00	(N/A)	0.00
9.50	0.00	(N/A)	0.00
10.00	0.00	(N/A)	0.00
10.50	0.00	(N/A)	0.00
11.00	0.00	(N/A)	0.00
11.50	23.46	(N/A)	0.00
12.00	72.73	(N/A)	0.00
12.50	145.30	(N/A)	0.00
13.00	241.71	(N/A)	0.00
13.50	362.95	(N/A)	0.00
14.00	510.18	(N/A)	0.00

Contributing Structures
None Contributing
None Contributing
None Contributing
None Contributing
None Contributing
None Contributing
None Contributing
None Contributing
None Contributing
None Contributing
None Contributing
None Contributing
None Contributing
None Contributing
Weir - 1
Weir - 1
Weir - 1
Weir - 1
Weir - 1
Weir - 1
Weir - 1

Composite Outlet Structure Detailed Report: E-1 Emergency Spillway



ATTACHMENT 2

HEC-HMS INPUT

C150132.00

ATTACHMENT 2

SEDIMENT BASIN E-1 HEC-HMS INPUT

8/23/2015

PRINCIPAL SPILLWAY STAGE DISCHARGE CURVE

(DEVELOPED FROM PONDPACK MODELING)

Paired Data | Table | Graph

Elevation (FT)	Discharge (CFS)
9.50	0.00
9.70	0.00
10.00	6.41
10.50	20.08
11.00	22.38
11.50	24.62
12.00	26.74
12.50	28.74
13.00	30.63
13.50	32.42
14.00	34.12

EMERGENCY SPILLWAY STAGE DISCHARGE CURVE

(DEVELOPED FROM PONDPACK MODELING)

Paired Data | Table | Graph

Elevation (FT)	Discharge (CFS)
10.0	0.00
10.5	0.00
11.0	0.00
11.5	23.45
12.0	72.73
12.5	145.30
13.0	241.71
13.5	362.95
14.0	510.18

C150132.00

ATTACHMENT 2

8/23/2015

SEDIMENT BASIN E-1 HEC-HMS INPUT

STAGE STORAGE CURVE

(DEVELOPED FROM POND E SUBGRADE CONTOURS)

Paired Data | Table | Graph

Elevation (FT)	Area (AC)
4.0000	1.58
6.0000	3.94
8.0000	4.32
10.0000	4.79
12.0000	7.08
14.0000	9.26

ATTACHMENT 3

HEC-HMS OUTPUT

C150132.01 **ATTACHMENT 3** 8/23/2014

SEDIMENT BASIN E-1 HEC-HMS OUTPUT

2-Year, 24-Hour Storm

Summary Results for Reservoir "Sed Pond E-1"

Project: Ponds D and E Simulation Run: 2-Year DE E&S
Reservoir: Sed Pond E-1

Start of Run:	30Mar2015, 00:00	Basin Model:	Pond D-E E&S Revisesd
End of Run:	01Apr2015, 23:00	Meteorologic Model:	2-yr Storm
Compute Time:	23Aug2015, 15:12:24	Control Specifications:	Control 1

Volume Units: ○ IN ◉ AC-FT

Computed Results

Peak Inflow:	145.1 (CFS)	Date/Time of Peak Inflow:	30Mar2015, 12:05
Peak Discharge:	20.5 (CFS)	Date/Time of Peak Discharge:	30Mar2015, 12:59
Inflow Volume:	12.8 (AC-FT)	Peak Storage:	26.2 (AC-FT)
Discharge Volume:	12.8 (AC-FT)	Peak Elevation:	10.6 (FT)

Summary Results for Sink "Principal Spillway"

Project: Ponds D and E Simulation Run: 2-Year DE E&S
Sink: Principal Spillway

Start of Run:	30Mar2015, 00:00	Basin Model:	Pond D-E E&S Revisesd
End of Run:	01Apr2015, 23:00	Meteorologic Model:	2-yr Storm
Compute Time:	23Aug2015, 15:12:24	Control Specifications:	Control 1

Volume Units: ○ IN ◉ AC-FT

Computed Results

Peak Discharge:	20.5 (CFS)	Date/Time of Peak Discharge	30Mar2015, 12:59
Volume:	12.8 (AC-FT)		

Summary Results for Sink "Emergency Spillway"

Project: Ponds D and E Simulation Run: 2-Year DE E&S
Sink: Emergency Spillway

Start of Run:	30Mar2015, 00:00	Basin Model:	Pond D-E E&S Revisesd
End of Run:	01Apr2015, 23:00	Meteorologic Model:	2-yr Storm
Compute Time:	23Aug2015, 15:12:24	Control Specifications:	Control 1

Volume Units: ○ IN ◉ AC-FT

Computed Results

Peak Discharge:	0.0 (CFS)	Date/Time of Peak Discharge	30Mar2015, 00:00
Volume:	0.0 (AC-FT)		

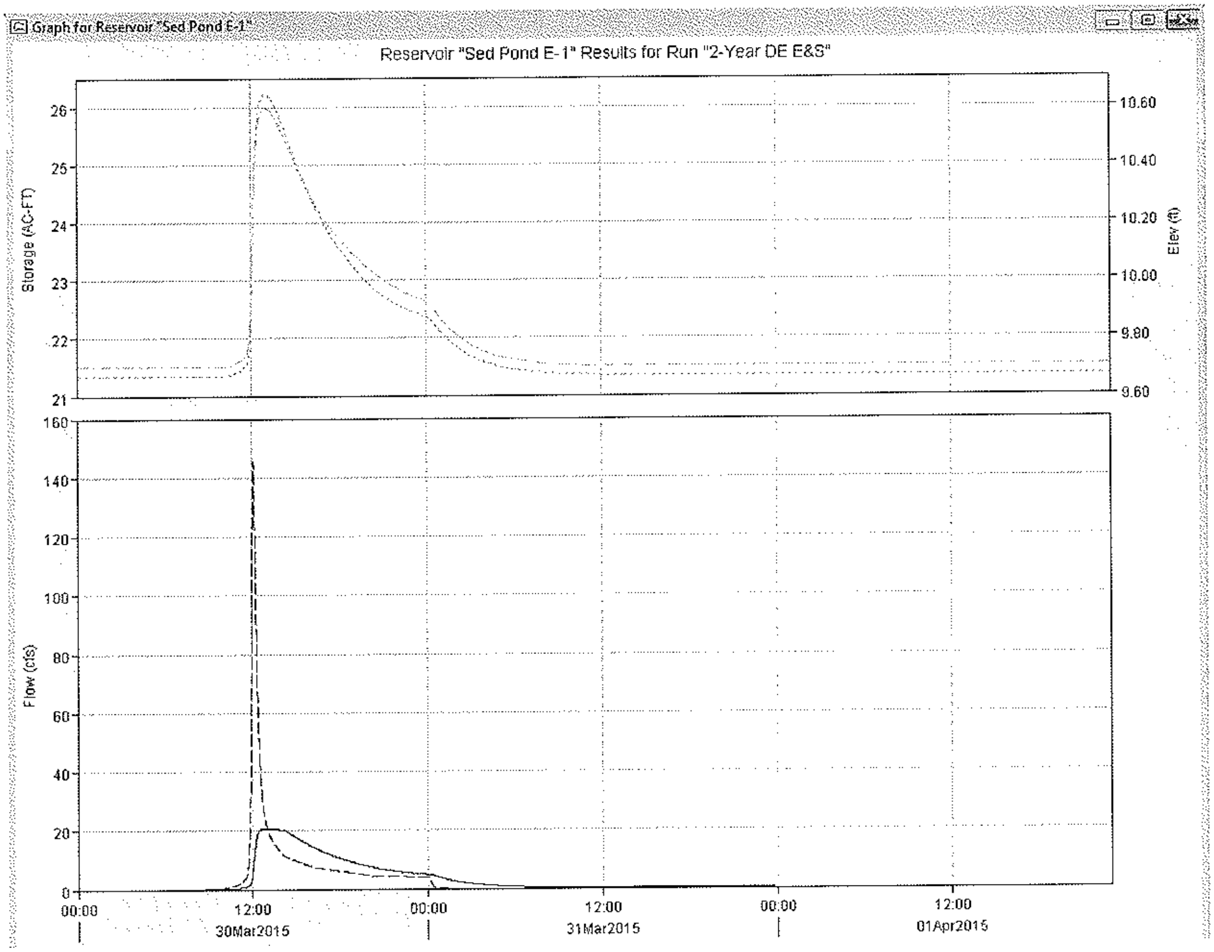
C150132.01

ATTACHMENT 3

8/23/2014

SEDIMENT BASIN E-1 HEC-HMS OUTPUT

2-Year, 24-Hour Storm



C150132.01

ATTACHMENT 3

8/23/2014

SEDIMENT BASIN E-1 HEC-HMS OUTPUT

25-Year, 24-Hour Storm

Summary Results for Reservoir "Sed Pond E-1"

Project: Ponds D and E   Simulation Run: 25-Year DE-E&S Revised
Reservoir: Sed Pond E-1

Start of Run:	30Mar2015, 00:00	Basin Model:	Pond D-E E&S Revisesd
End of Run:	01Apr2015, 23:00	Meteorologic Model:	25-yr Storm
Compute Time:	23Aug2015, 15:15:05	Control Specifications:	Control 1

Volume Units: IN (•) AC-FT

Computed Results

Peak Inflow:	604.6 (CFS)	Date/Time of Peak Inflow:	30Mar2015, 12:04
Peak Discharge:	28.9 (CFS)	Date/Time of Peak Discharge:	30Mar2015, 12:26
Inflow Volume:	47.3 (AC-FT)	Peak Storage:	39.0 (AC-FT)
Discharge Volume:	27.5 (AC-FT)	Peak Elevation:	12.5 (FT)

Summary Results for Sink "Principal Spillway"

Project: Ponds D and E   Simulation Run: 25-Year DE-E&S Revised
Sink: Principal Spillway

Start of Run:	30Mar2015, 00:00	Basin Model:	Pond D-E E&S Revisesd
End of Run:	01Apr2015, 23:00	Meteorologic Model:	25-yr Storm
Compute Time:	23Aug2015, 15:15:05	Control Specifications:	Control 1

Volume Units: IN (•) AC-FT

Computed Results

Peak Discharge:	28.9 (CFS)	Date/Time of Peak Discharge	30Mar2015, 12:26
Volume:	27.5 (AC-FT)		

Summary Results for Sink "Emergency Spillway"

Project: Ponds D and E   Simulation Run: 25-Year DE-E&S Revised
Sink: Emergency Spillway

Start of Run:	30Mar2015, 00:00	Basin Model:	Pond D-E E&S Revisesd
End of Run:	01Apr2015, 23:00	Meteorologic Model:	25-yr Storm
Compute Time:	23Aug2015, 15:15:05	Control Specifications:	Control 1

Volume Units: IN (•) AC-FT

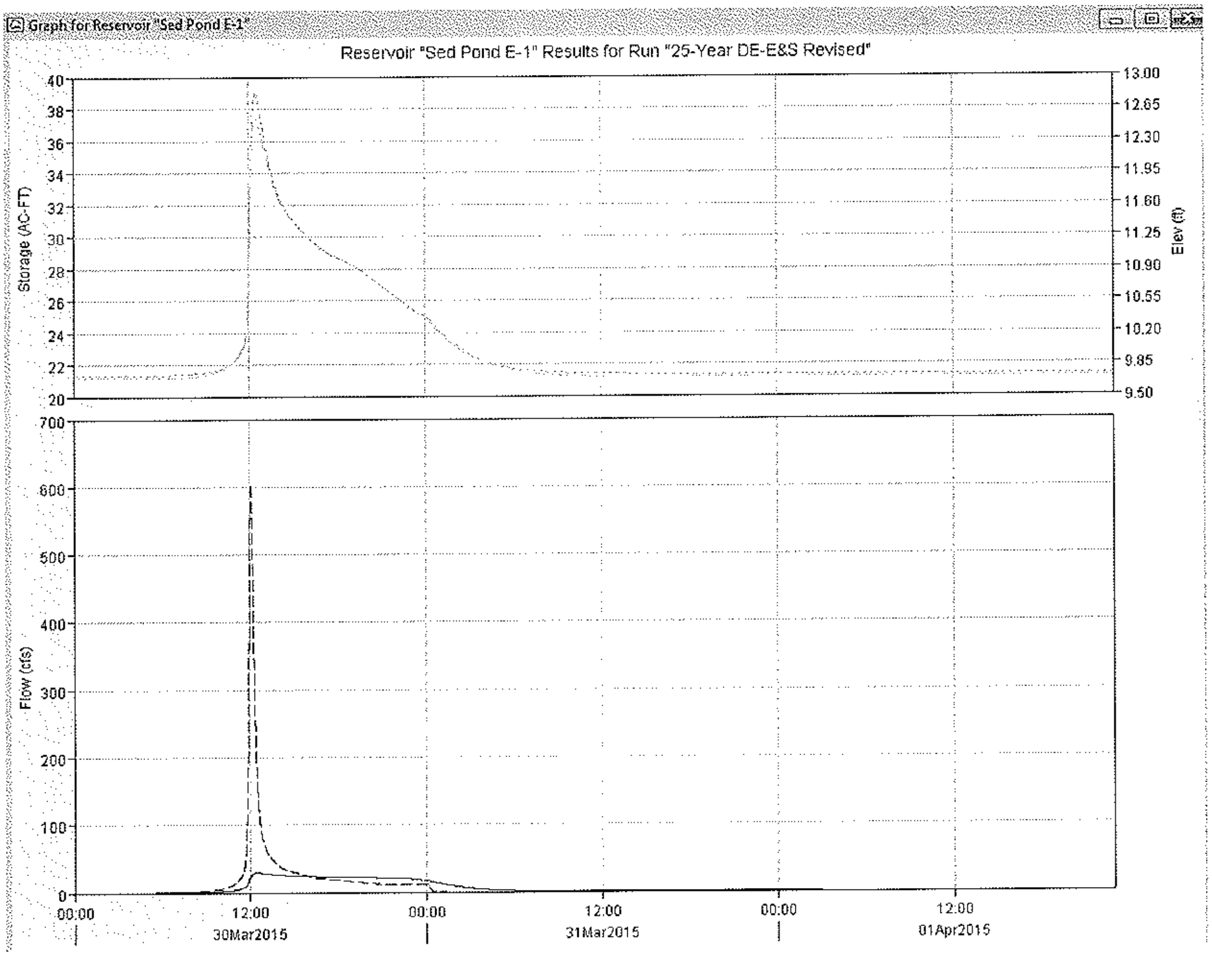
Computed Results

Peak Discharge:	154.8 (CFS)	Date/Time of Peak Discharge	30Mar2015, 12:26
Volume:	19.8 (AC-FT)		

C150132.01 **ATTACHMENT 3** 8/23/2014

SEDIMENT BASIN E-1 HEC-HMS OUTPUT

25-Year, 24-Hour Storm



ATTACHMENT 4

OUTLET PROTECTION CALCULATIONS

DESIGN OF OUTLET PROTECTION FROM A ROUND PIPE FLOWING FULL
MINIMUM TAILWATER CONDITION (T_w < 0.5 DIAMETER)

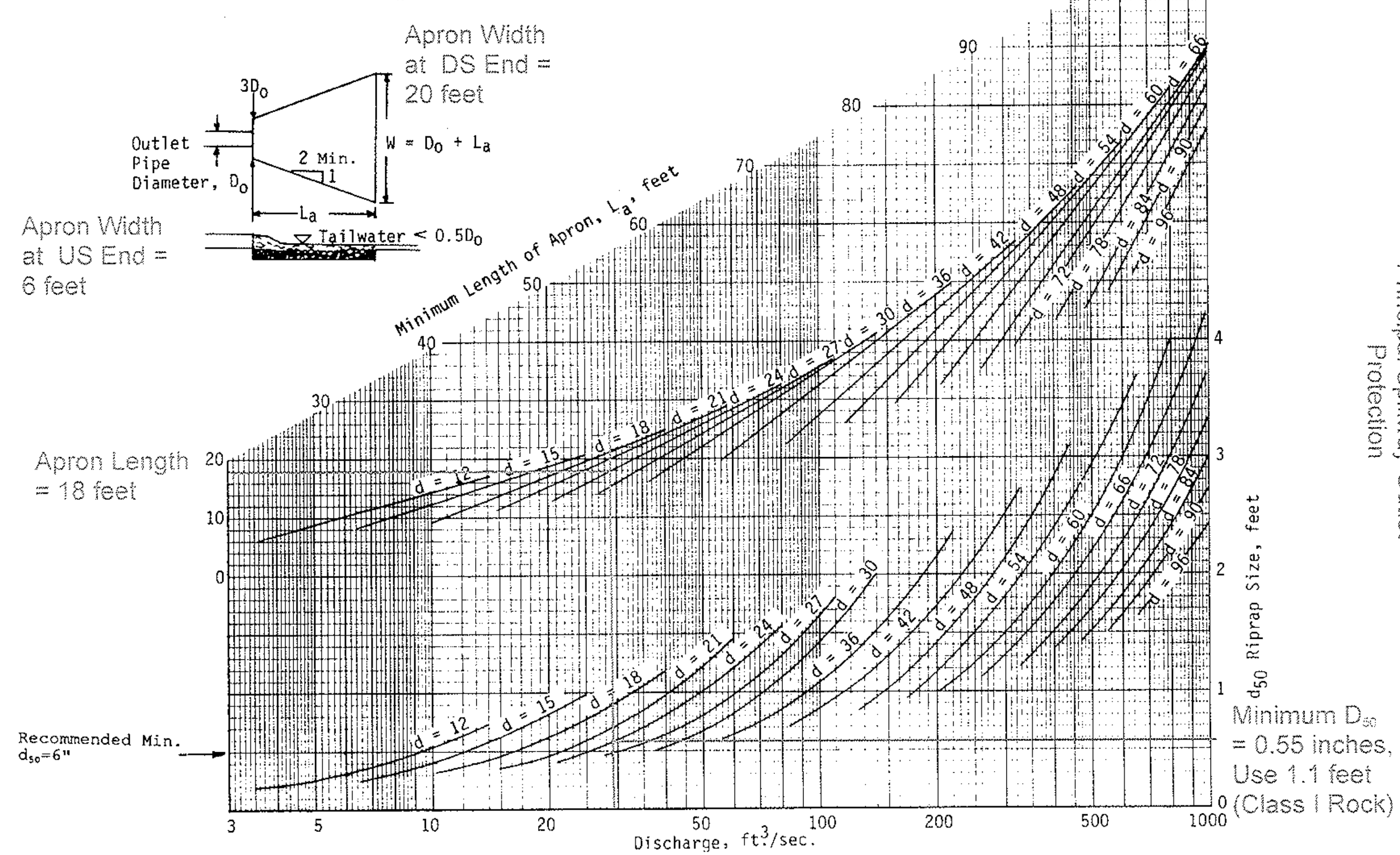


TABLE 3.19-B

GRADED RIPRAP - DESIGN VALUES

Riprap Class	D_{15} Weight (lbs.)	Mean D_{15} Spherical Diameter (ft.)	Mean D_{50} Spherical Diameter (ft.)	
Class AI	25	0.7	0.9	Principal Spillway
Class I	50	0.8	1.1	Emergency Spillway
Class II	150	1.3	1.6	
Class III	500	1.9	2.2	
Type I	1,500	2.6	2.8	
Type II	6,000	4.0	4.5	

Source: VDOT Drainage Manual

The designer, after determining the riprap size that will be stable under the flow conditions, shall consider that size to be a minimum size and then, based on riprap gradations actually available in the area, select the size or sizes that equal or exceed the minimum size. The possibility of damage by children shall be considered in selecting a riprap size, especially if there is nearby water or a gully in which to toss the stones.

Thickness

The minimum thickness of the riprap layer shall be 2 times the maximum stone diameter, but not less than 6 inches.

Quality of Stone

Stone for riprap shall consist of field stone or rough unhewn quarry stone of approximately rectangular shape. The stone shall be hard and angular and of such quality that it will not disintegrate on exposure to water or weathering and it shall be suitable in all respects for the purpose intended. The specific gravity of the individual stones shall be at least 2.5.

Rubble concrete may be used provided it has a density of at least 150 pounds per cubic foot, and otherwise meets the requirement of this standard and specification.

ATTACHMENT 5

FILTER DIAPHRAGM CALCULATIONS

SUBJECT:	Possum Point CCR Pond Closures - Sediment Basin E-1				
By:	BerkeME	Date:	10/9/2015	Project No.	C150132.00
Chkd By:	SCHELAB	Date:	10/12/2015	Sheet No.	

gai consultants

Filter Diaphragm Design

References:

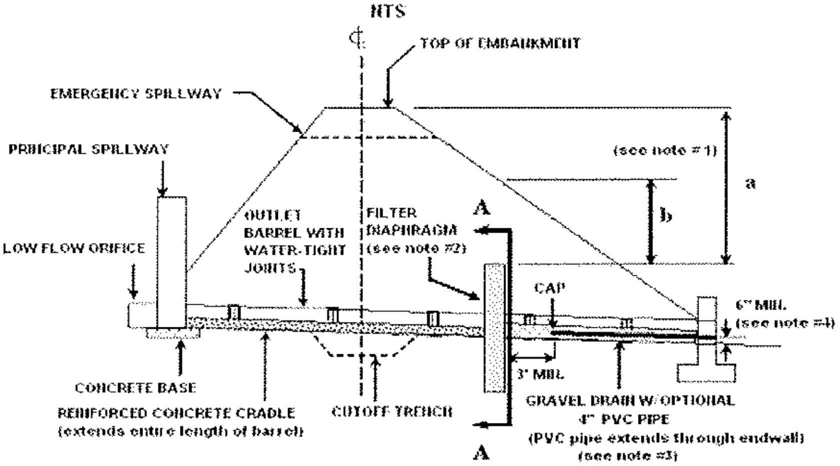
1) United States Department of Agriculture (USDA), Soil Conservation Service, Dimensioning of Filter-Drainage Diaphragms for Conduits According to TR-60", April 1985

2) United States Department of Agriculture (USDA), Soil Conservation Service, Supplement to Dimensioning of Filter-Drainage Diaphragms for Conduits According to TR-60", April 1985

3) National Engineering Handbook (NEH), Part 628 Dams, Chapter 45-Filter Diaphraghms, January 2007.

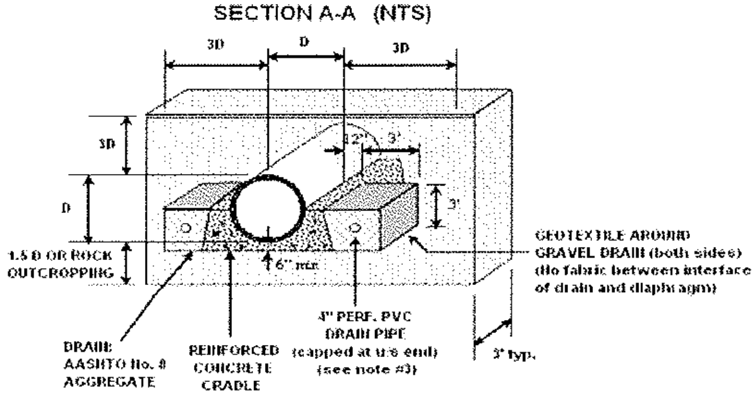
The following Figure, taken from the Pennsylvania Department of Environmental Protection "Erosion and Sediment Pollution Control Program Manual", March 2012 illustrates the criteria outlined in the above publications.

NTS



Notes:
1. Diaphragm should belocated d/s of embankment centerline and cutoff trench and u/s of a point where b = 0.5 a
2. Diaphragm should be constructed using a specially graded sand (Typically Type A concrete sand)
3. Optional drin pipe should have maximum 3/16" perforations if used in AASHTO No. 8 drain.
4. Outlet of drain should be located at least 6" above invert of outlet conduit.

SECTION A-A (NTS)



SUBJECT:	Possum Point CCR Pond Closures - Sediment Basin E-1				
By:	BerkeME	Date:	10/9/2015	Project No.	C150132.00
Chkd By:	SCHELAB	Date:	10/12/2015	Sheet No.	

Based on the above guidance, the following dimensions were selected for design

Conduit Diameter, D =	1.83 ft
Outside Diameter, Do =	2.00 ft
3Do =	6 ft
Top of Embankment Elevation =	18 ft
Invert of Principal Spillway Barrel at Section A-A=	7.09 ft
Top of Diaphragm at Section A-A=	14.76 ft
Max WSE in Pond =	12.50 ft
Set Top of Diaphragm at Section A-A to Max WSE=	12.50 ft
a=	5.5 ft
b min =	2.75 ft
b=	3 ft

b is estimated from profile drawing)

TR-60 criteria states that b must be greater than or equal to 0.5a, so the diaphragm location meets the criteria.

Filter Diaphragm Outlet Design-Follows Example 2 From Reference 2

Find: Area of drain outlet

Construct Phreatic Line by Casagrande method

Top of Embankment Elevation (Settled), TE =	18 ft
Top of Diaphragm El., TD=	12.50 ft
Emergency Spillway Crest El., ES =	11 ft
Principal Spillway Crest El., PS =	9.7 ft
Toe of Upstream Embankment, TU =	4 ft
Outlet Channel El., OC =	7 ft
Embankment Side Slope (Upstream Side), Z1 =	3.0:1
Embankment Side Slope (Downstream Side), Z2 =	3:01
Embankment Top Width (Settled), TW =	25 ft

m is the distance from where water surface intersects the slope to the toe of the embankment

1. 0.33m= 1/3 * [(PS-TU)*3] =	5.7 ft
m =	17 ft
2. d (estimate from plan view drawing) =	94 ft
3. hy = PS-OC =	2.7 ft
4. Yo= (hy^2 +d^2)^0.5 - d =	0.04 ft

SUBJECT:	Possum Point CCR Pond Closures - Sediment Basin E-1				
By:	BerkeME	Date:	10/9/2015	Project No.	C150132.00
Chkd By:	SCHELAB	Date:	10/12/2015	Sheet No.	

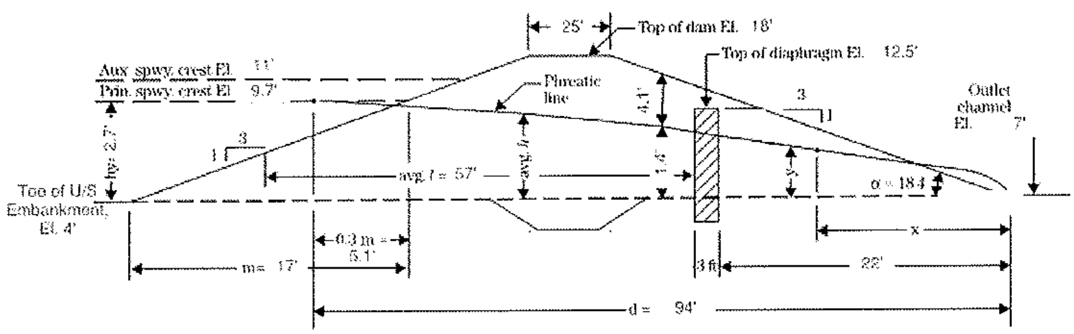
5. Calculate values of y corresponding to various values of x.

y=(2Yox + Yo^2)^0.5

x	y
10	0.9
22	1.3
25	1.4
94	2.7

6. Plot basic parabola as the phreatic line of the structure layout

Figure 45C–5 Structure layout and phreatic line computation



(210–VI–NEH, January 2007) 45C–7

<u>Calculate Design Q for Filter Diaphragm</u>

Use Darcy's Law, Q=KiA

1. Seepage Zone eqauls average height under phreatic line times width of diaphragm

Width of Diaphragm, W = 14 ft

A = (3.0+2.1)/2 x W = 29 sq ft

2. Hydraulic gradient, i=h/l

h = difference between emergency spillway and the height where the phreatic line hits the upstream face of the diaphragm.

h= ES- (OC + 1.4) = 2.6 ft

l= average seepage flow path from midpoint between the upstream toe of the embankment to the principal spillway crest, horizontally to the face of the diaphragm.

l= 57 ft (measured from drawing)

i= h/l = 0.046

3. Permeability coefficeint, K

K= 1 ft/day (taken from Ref 2, example 2)

For conservatism, assume embankment permeability is 100 times actual estimated permeability (0.01 ft/day)

SUBJECT:	Possum Point CCR Pond Closures - Sediment Basin E-1		
By:	BerkeME Date: 10/9/2015	Project No.	C150132.00
Chkd By:	SCHELAB Date: 10/12/2015	Sheet No.	

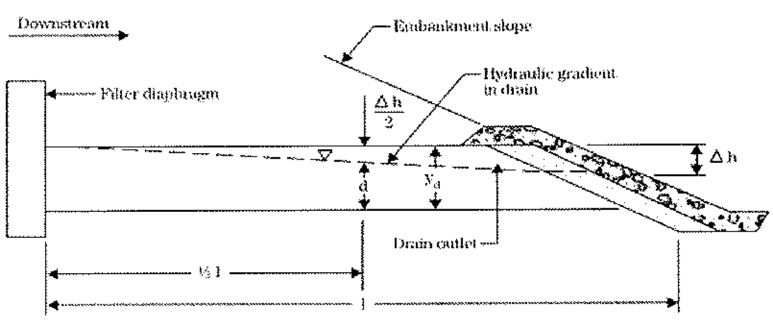
4. Design Q using Darcy's Law

Q=KiA= 1.3 cf/day

Calculate area of outlet for Filter Diaphragm

1. Consider the height of the drain as the height corresponding to the area calculated by Darcy's Law plus half of the hydraulic gradient in the drain.

Figure 45C–7 Filter diaphragm to the downstream toe

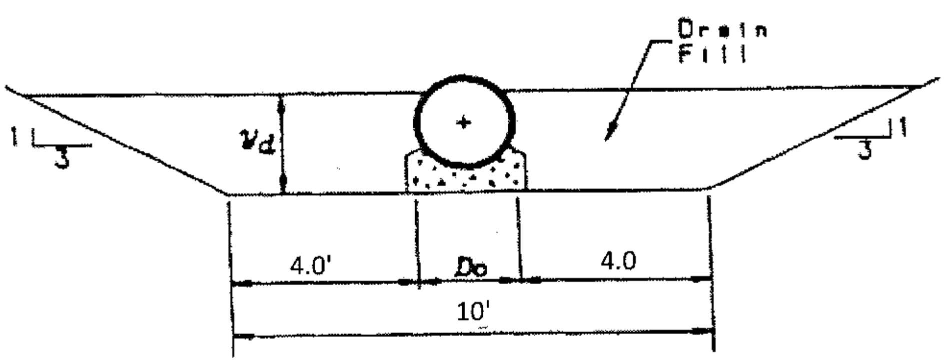


(210-VI-NEH, January 2007)

2. Calculate the average flow are of the drain outlet by Darcy's Law

GIVEN:

Q =	1.3 cf/day		
i=h/l = h/22			
l=	22		
Kf for drain outlet =	20 ft/day (From Reference 2 example)		
Q=KiA, A=Q/Kfi =	0.1 /i		
		a	3
yd=d+h/2		b	8
3d^2 + 8 d - A = 0	to solve quadratic equation:	c	A



OUTLET FOR DIAPHRAGM

SUBJECT: Possum Point CCR Pond Closures - Sediment Basin E-1

By:	BerkeME	Date:	10/9/2015	Project No.	C150132.00
Chkd By:	SCHELAB	Date:	10/12/2015	Sheet No.	

Test several h to find minimum Yd

h	i=h/22	A=0.1/i		d1	d2	Yd
0.3	0.0114	5.8	133.19	0.59	-3.26	0.72
0.5	**0.0227**	**2.9**	**98.60**	**0.32**	**-2.99**	**0.57**
1.0	0.0455	1.4	81.30	0.17	-2.84	0.67
1.5	0.0682	1.0	75.53	0.12	-2.78	0.87
2.0	0.0909	0.7	72.65	0.09	-2.75	1.09
2.5	0.1136	0.6	70.92	0.07	-2.74	1.32
3.0	0.1364	0.5	69.77	0.06	-2.73	1.56
3.5	0.1591	0.4	68.94	0.05	-2.72	1.80
4.0	0.1818	0.4	68.32	0.04	-2.71	2.04

Use Yd= 0.60 ft

3. Area of drain outlet

A=3Yd^2+8Yd= 5.9 ft^2

INTRODUCTION

This calculation will size a proposed temporary sediment basin and associated outlet structures in Borrow Area #1 for sediment control during construction. Storage and discharge requirements are based on Virginia Erosion and Sediment Control (E&S) handbook.

REFERENCES

1. Virginia E&S Control Handbook, Virginia Department of Environmental Quality, 1992.

ATTACHMENTS

1. Pond Pack Spillway Rating Curve
2. HEC-HMS Input
3. HEC-HMS Output
4. Filter Diaphragm Calculations

STORAGE REQUIRED

From the Virginia E&S Regulations, the following storage criteria are utilized for the Sedimentation Basin:

- Capacity of at least 134 cubic yards per contributing acre
- 67 cubic yards per acre is to be permanent pool
- 67 cubic yards is to be drawdown area
- Sediment cleanout shall occur when wet storage is reduced to 34 cubic yards per acre (sediment occupies 33 cubic yards per acre)

The storage required in the basin considers the entire area outlined on the plan drawings (~20 acres). The Outlet structures for the Basin are designed considering the actual development anticipated (Grading shown on the plans) for the borrow area (~10 acres). If the contractor plans to develop locations outside of the currently proposed grading, the outlet works for the proposed basin will need to be evaluated and an emergency spillway may need to be added to the basin.

Storage Required continued

20 acres total draining to the Sediment Pond
67 cy per watershed acre of wet volume yields
1,347 cy wet volume required
0.83 acre-feet wet volume required

67 cy per watershed acre of dry volume yields
1,347 cy dry volume required
0.83 acre-feet dry volume required

33 cy per watershed acre required sediment cleanout volume, maximum
663 cy volume at maximum sediment cleanout level
0.41 acre-feet volume at maximum sediment cleanout level

STORAGE PROVIDED

Assess the storage provided in the Sedimentation Basin and establish required wet and dry storage levels. Use average areas between elevations to calculate volume. Data in italics are interpolated for the given elevation.

Basin Stage Storage

Elevation (ft)	Surface Area (ft^2)	Surface Area (ac)	Incremental Volume (cf)	Incremental Volume (ac-ft)	Total Volume (cf)	Total Volume (ac-ft)	
90	45,259	1.04		0.00	0	0.00	
90.5	*46,675*	*1.07*	*22,984*	*0.53*	*22,984*	*0.53*	*<--- Sediment Cleanout Elev.*
91	48,091	1.10	23,692	0.54	46,675	1.07	*<--- Wet Volume Elev. (Orifice Invert)*
92	51,010	1.17	49,551	1.14	96,226	2.21	*<--- Dry Volume Elev. (Riser Crest)*
92.5	*52,513*	*1.21*	25,881	0.59	122,106	2.80	
93	54,015	1.24	26,632	0.61	148,738	3.41	
93.5	*55,562*	*1.28*	27,394	0.63	176,132	4.04	
94	57,109	1.31	28,168	0.65	204,300	4.69	
95	60,289	1.38	58,699	1.35	262,999	6.04	*<--- Basin Embankment Crest Elev.*

SUBJECT POSSUM POINT CCR POND CLOSURES
SEDIMENT BASIN DESIGN – BORROW AREA 1

BY SCHELAB DATE 8/31/2015 PROJ. NO. C150132.00

CHKD. BY PATTEJR DATE 8/31/2015

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DISCHARGE REQUIREMENTS

From the Virginia E&S Regulations, the principal spillway must meet the following:

- The principal spillway must pass the peak flow from a 2-year 24-hour storm;
- If an emergency spillway is not used, a minimum of 3-ft of freeboard must be provided between the crest of the principal spillway and the top of the embankment;
- The principal spillway must pass the 25-year, 24-hour storm with 2 ft of freeboard to the embankment crest.

The Spillway Will Consist of:

- 3.0-foot diameter High Density Polyethylene (HDPE) pipe used as a riser (crest elevation 92.0 feet)
- 1.5-foot diameter HDPE pipe used as a barrel
(Upstream Invert = 89 feet, Downstream Invert = 84 feet)

HYDRAULIC ANALYSIS

Rating curves for the spillway structures identified above are developed using the composite outlet structures feature of Pond Pack Version 8i (Attachment 1). The rating curves are then input into the HEC-HMS developed model for the site (Site Hydrology Calculations).

HEC-HMS output data is included as Attachment 3.

ADDITIONAL DESIGN FEATURES

Principal Spillway Outlet Protection
Outlet protection for the 18-inch principal spillway barrel is sized to protect against erosion for the 25-year storm based on Sections 3.18 (Outlet Protection) and 3.19 (Riprap) of the VA E&S manual. The pipe discharges into a local depression upstream of an existing culvert. As such, a typical outlet protection apron is not utilized.

Riprap D_{50} = 1.1 feet (VDOT Class I)

DEWATERING

Virginia E&S Regulations state that the dewatering orifice must dewater the dry storage volume in a minimum of 6 hours. From the regulations:

A = flow area of orifice, in square feet

d = diameter of circular orifice, in feet

h = average driving head (maximum possible head measured from radius of orifice to crest of principal spillway divided by 2), in feet

Q = volumetric flowrate through orifice needed to achieve approximate 6-hour drawdown, cubic feet per second

S = total storage available in dry storage area, cubic feet

Q = S / 21,600 seconds

Use S for basin and find Q. Then substitute in calculated Q and find A:

$$A = \frac{Q}{\left(64.32 \; x \; h\right)^{\frac{1}{2}} \; (0.6)}$$

Then, substitute in calculated A and find d:

$$d* = 2 \; x \left(\frac{A}{3.14}\right)^{\frac{1}{2}}$$

The Temporary Sediment Basin for Borrow Area 1 is designed to dewater in12-hours.

SUBJECT	POSSUM POINT CCR POND CLOSURES SEDIMENT BASIN DESIGN – BORROW AREA 1

BY SCHELAB DATE 10/13/2015 PROJ. NO. C150132.00

CHKD. BY PATTEJR DATE 10/14/2015

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Dewatering continued

S = dry storage available =	1.14 acre-feet
S = 49,658 cubic feet	
Use drawdown of 12 hours =	43,200 sec
Q = S / 43,200 seconds =	1.1 cfs
Invert elevation of orifice =	91
Riser crest elevation =	92
Average head =	0.50 feet
Orifice Diameter =	6.00 inches
Orifice Area =	0.20 sf
Number of Orifices =	2
Flow Provided =	1.3 cfs
Dewatering Time =	10.3 hours

ANTI-SEEP COLLARS

Determine the Length of the Barrel within the saturated zone:

$$L_s = Y(Z + 4)\left(1 + \frac{S}{0.25 - S}\right)$$

where:

L_s = length of barrel in the saturated zone, feet

Y = the depth of water at the principal spillway crest, feet

Z = slope of the upstream face of embankment in Z feet horizontal to one vertical

S = slope of the barrel in feet per foot

Y = 2 ft
Z = 3
S = .0714 ft/ft
L_s = 19.6 ft
L_f = 1.1 x Ls = 21.56 ft
Assume 2 Collars will be used
V_{min} = 0.1 x Ls / 4 = 0.5 ft (use 1')
Spacing = 14 x V_{min} = 7.0 ft (use 6')

FILTER DIAPHRAGMS

Filter diaphragms may be used in lieu of Anti-Seep Collars. Refer to attached Filter Diaphragm calculation.

SUBJECT POSSUM POINT CCR POND CLOSURES
SEDIMENTAT BASIN DESIGN – BORROW AREA 1

BY SCHELAB DATE 8/31/2015 PROJ. NO. C150132.00

CHKD. BY PATTEJR DATE 8/31/2015

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ATTACHMENT 1

POND PACK SPILLWAY RATING CURVES

Composite Outlet Structure Detailed Report: Borrow Area 1 Principal Spillway

Element Details

Label	Borrow Area 1 Principal Spillway	Notes	

Headwater Range

Headwater Type	User Defined Headwater	Increment (Headwater)	0.50 ft
Minimum (Headwater)	90.00 ft	Maximum (Headwater)	96.00 ft

SpotElevation (ft)

Tailwater Setup

Tailwater Type	Free Outfall

Tailwater Tolerances

Maximum Iterations	30	Tailwater Tolerance (Maximum)	0.50 ft
Headwater Tolerance (Minimum)	0.01 ft	Flow Tolerance (Minimum)	0.001 ft³/s
Headwater Tolerance (Maximum)	0.50 ft	Flow Tolerance (Maximum)	10.000 ft³/s
Tailwater Tolerance (Minimum)	0.01 ft		

Outlet Structure

Outlet Structure Type	Riser

Outlet Structure (IDs and Direction)

Outlet ID	Riser - 1	Downstream ID	Culvert - 1
Flow Direction	Forward and Reverse Flow	Notes	

Outlet Structure (Advanced)

Elevation (On)	0.00 ft	Elevation (Off)	0.00 ft

Outlet Structure (Riser)

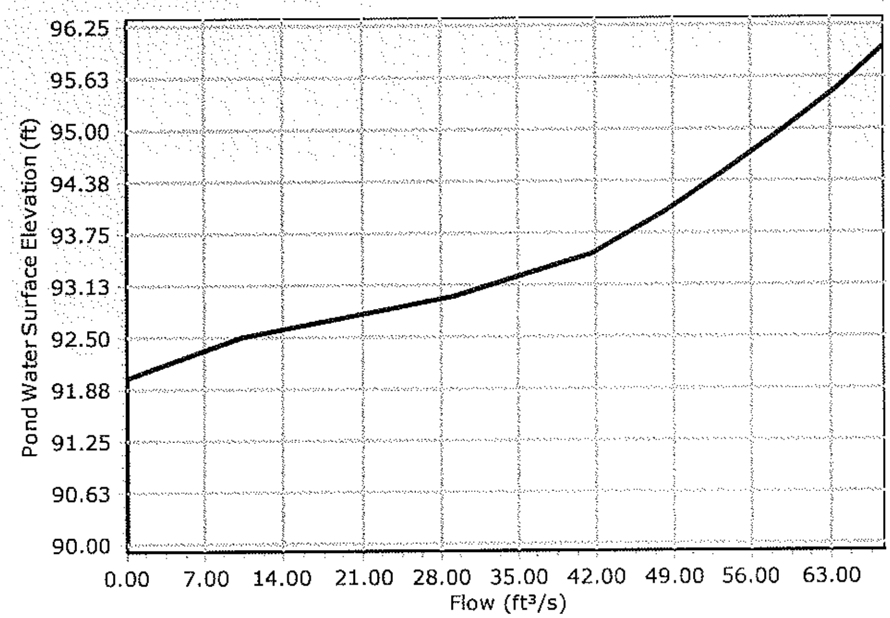
Riser	Stand Pipe	Transition Elevation	0.00 ft
Diameter	36.0 in	Transition Height	0.00 ft
Weir Coefficient	3.10 (ft^0.5)/s	K Reverse	1.000
Orifice Coefficient	0.600		

Outlet Structure (Common)

Elevation	92.00 ft

Composite Outlet Structure Detailed Report: Borrow Area 1 Principal Spillway

Outlet Structure (Riser, Advanced)			
Use Orifice Depth to Crest?	True	Use Submerged Weir Equation?	False



RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Riser - 1 (Stand Pipe)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft^3/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)
90.00	0.00	0.00	0.00	0.00
90.50	0.00	0.00	0.00	0.00
91.00	0.00	0.00	0.00	0.00
91.50	0.00	0.00	0.00	0.00
92.00	0.00	0.00	0.00	0.00
92.50	10.33	92.50	Free Outfall	91.31
93.00	29.22	93.00	93.00	93.00
93.50	41.67	93.50	93.50	93.50
94.00	48.11	94.00	94.00	94.00
94.50	53.79	94.50	94.50	94.50
95.00	58.93	95.00	95.00	95.00

Composite Outlet Structure Detailed Report: Borrow Area 1 Principal Spillway

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Riser - 1 (Stand Pipe)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)
95.50	63.65	95.50	95.50	95.50
96.00	68.04	96.00	96.00	96.00

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00

Message
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
Weir: H =0.5ft
FULLY CHARGED RISER: ADJUSTED TO WEIR: H =1ft
FULLY CHARGED RISER, DOWNSTREAM CONTROL: Kev=0. Hev=0.000
FULLY CHARGED RISER, DOWNSTREAM CONTROL: Kev=0. Hev=0.000
FULLY CHARGED RISER, DOWNSTREAM CONTROL: Kev=0. Hev=0.000
FULLY CHARGED RISER, DOWNSTREAM CONTROL: Kev=0. Hev=0.000

Composite Outlet Structure Detailed Report: Borrow Area 1 Principal Spillway

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Riser - 1 (Stand Pipe)

Upstream ID = (Pond Water Surface)
Downstream ID = Culvert - 1 (Culvert-Circular)

Message
FULLY CHARGED RISER, DOWNSTREAM CONTROL: Kev=0. Hev=0.000
FULLY CHARGED RISER, DOWNSTREAM CONTROL: Kev=0. Hev=0.000

Outlet Structure

Outlet Structure Type	Culvert	Culvert Type	Circular

Outlet Structure (IDs and Direction)

Outlet ID	Culvert - 1	Downstream ID	Tailwater
Flow Direction	Forward and Reverse Flow	Notes	

Outlet Structure (Advanced)

Elevation (On)	0.00 ft	Elevation (Off)	0.00 ft

Culvert Data

Number of Barrels	1	Downstream Invert	84.00 ft
Length	70.00 ft	Diameter	18.0 in
Upstream Invert	89.00 ft		

Unsubmerged->Submerged

Specify Transitions	False	Compute Inlet Control Only	False

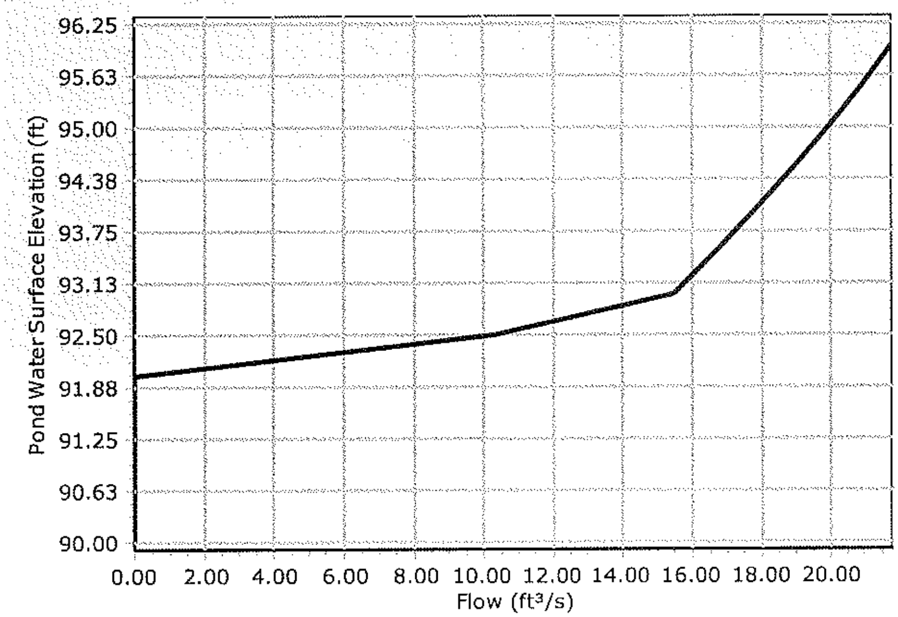
Culvert Coefficients

Inlet Description	Concrete - Square edge w/headwall	C	0.0398
Chart	Chart 1	Y	0.6700
Nomograph	Nomograph 1	Manning's n	0.013
Equation Form	Form 1	Ke	0.500
K	0.0098	Kr	0.000
M	2.0000	Slope Correction Factor	-0.500

Culvert (Advanced)

Convergence Tolerance	0.00 ft	Specify Number of Backwater Sections	False

Composite Outlet Structure Detailed Report: Borrow Area 1 Principal Spillway



RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Culvert - 1 (Culvert-Circular)

Mannings open channel maximum capacity: 30.20 ft³/s
Upstream ID = Riser - 1 (Stand Pipe)
Downstream ID = Tailwater (Pond Outfall)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)
90.00	0.00	0.00	0.00	Free Outfall
90.50	0.00	0.00	0.00	Free Outfall
91.00	0.00	0.00	0.00	Free Outfall
91.50	0.00	0.00	0.00	Free Outfall
92.00	0.00	0.00	0.00	Free Outfall
92.50	10.33	91.31	Free Outfall	Free Outfall
93.00	15.47	93.00	Free Outfall	Free Outfall
93.50	16.69	93.50	Free Outfall	Free Outfall
94.00	17.82	94.00	Free Outfall	Free Outfall
94.50	18.89	94.50	Free Outfall	Free Outfall
95.00	19.90	95.00	Free Outfall	Free Outfall
95.50	20.86	95.50	Free Outfall	Free Outfall
96.00	21.79	96.00	Free Outfall	Free Outfall

Composite Outlet Structure Detailed Report: Borrow Area 1 Principal Spillway

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Culvert - 1 (Culvert-Circular)

Mannings open channel maximum capacity: 30.20 ft^3/s
Upstream ID = Riser - 1 (Stand Pipe)
Downstream ID = Tailwater (Pond Outfall)

Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft^3/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	0.00	(N/A)	0.00
0.00	13.75	(N/A)	0.00
0.00	24.98	(N/A)	0.00
0.00	30.29	(N/A)	0.00
0.00	34.90	(N/A)	0.00
0.00	39.02	(N/A)	0.00
0.00	42.78	(N/A)	0.00
0.00	46.26	(N/A)	0.00

Message
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
INLET CONTROL... Submerged: HW =2.31
INLET CONTROL... Submerged: HW =4.00
INLET CONTROL... Submerged: HW =4.50
INLET CONTROL... Submerged: HW =5.00
INLET CONTROL... Submerged: HW =5.50
INLET CONTROL... Submerged: HW =6.00
INLET CONTROL... Submerged: HW =6.50
INLET CONTROL... Submerged: HW =7.00

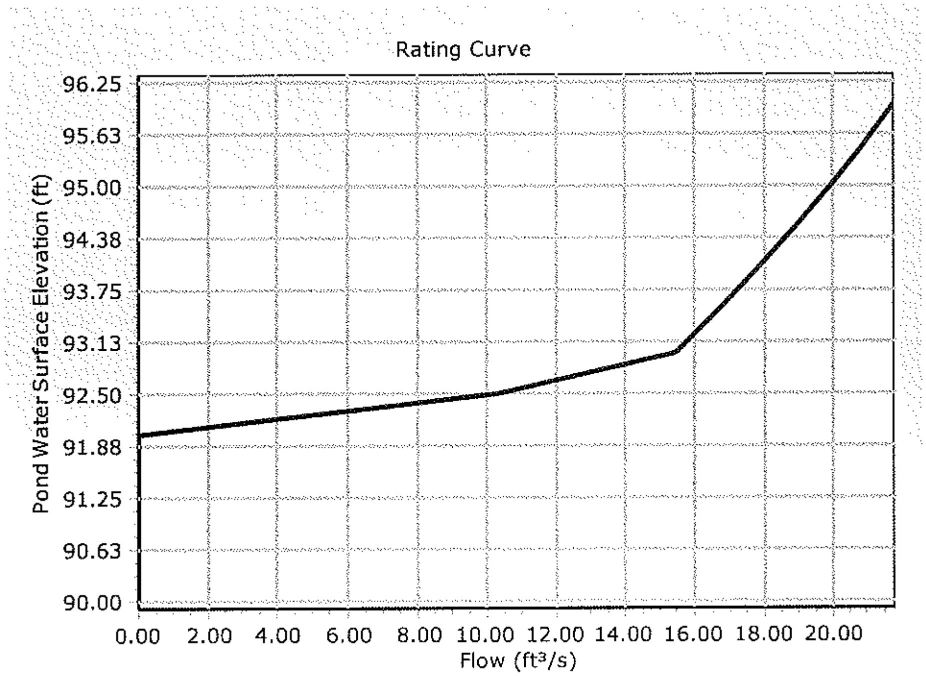
Composite Outlet Structure Detailed Report: Borrow Area 1 Principal Spillway

Composite Rating Table
Tailwater Elevation = Free Outfall (Borrow Area 1 Principal Spillway)

Water Surface Elevation (ft)	Flow (ft^3/s)	Tailwater Elevation (ft)	Convergence Error (ft)
90.00	0.00	(N/A)	0.00
90.50	0.00	(N/A)	0.00
91.00	0.00	(N/A)	0.00
91.50	0.00	(N/A)	0.00
92.00	0.00	(N/A)	0.00
92.50	10.33	(N/A)	0.00
93.00	15.47	(N/A)	0.00
93.50	16.69	(N/A)	0.00
94.00	17.82	(N/A)	0.00
94.50	18.89	(N/A)	0.00
95.00	19.90	(N/A)	0.00
95.50	20.86	(N/A)	0.00
96.00	21.79	(N/A)	0.00

Contributing Structures
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
(no Q: Riser - 1,Culvert - 1)
Riser - 1,Culvert - 1
Riser - 1,Culvert - 1
Riser - 1,Culvert - 1
Riser - 1,Culvert - 1
Riser - 1,Culvert - 1
Riser - 1,Culvert - 1
Riser - 1,Culvert - 1
Riser - 1,Culvert - 1

Composite Outlet Structure Detailed Report: Borrow Area 1 Principal Spillway



SUBJECT POSSUM POINT CCR POND CLOSURES
SEDIMENTAT BASIN DESIGN – BORROW AREA 1

BY SCHELAB DATE 8/31/2015 PROJ. NO. C150132.00

CHKD. BY PATTEJR DATE 8/31/2015

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ATTACHMENT 2

HEC-HMS INPUT

PRINCIPAL SPILLWAY STAGE DISCHARGE CURVE

(DEVELOPED FROM PONDPACK MODELING)

Paired Data | Table | Graph

Elevation (FT)	Discharge (CFS)
92.00	0.00
92.50	10.33
93.00	15.47
93.50	16.69
94.00	17.82
94.50	18.89
95.00	19.90
95.50	20.86
96.00	21.79

STAGE STORAGE CURVE

(DEVELOPED FROM BORROW AREA 1 CONTOURS)

Paired Data | Table | Graph

Elevation (FT)	Area (AC)
90.0	1.04
91.0	1.10
92.0	1.17
93.0	1.24
94.0	1.31
95.0	1.41

SUBJECT POSSUM POINT CCR POND CLOSURES
SEDIMENTAT BASIN DESIGN – BORROW AREA 1

BY SCHELAB DATE 8/31/2015 PROJ. NO. C150132.00

CHKD. BY PATTEJR DATE 8/31/2015

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ATTACHMENT 3

HEC-HMS OUTPUT

BORROW AREA 1 HEC-HMS OUTPUT

2-Year, 24-Hour Storm

Summary Results for Reservoir "Borrow Area 1 Basin"

Project: Ponds D and E Simulation Run: 2-Year Borrow Area 1
Reservoir: Borrow Area 1 Basin

Start of Run:	30Mar2015, 00:00	Basin Model:	BORROW AREA 1
End of Run:	01Apr2015, 23:00	Meteorologic Model:	2-yr Storm
Compute Time:	31Aug2015, 20:02:52	Control Specifications:	Control 1

Volume Units: ○ IN ◉ AC-FT

Computed Results

Peak Inflow:	22.1 (CFS)	Date/Time of Peak Inflow:	30Mar2015, 11:57
Peak Discharge:	6.6 (CFS)	Date/Time of Peak Discharge:	30Mar2015, 12:06
Inflow Volume:	1.1 (AC-FT)	Peak Storage:	2.6 (AC-FT)
Discharge Volume:	1.1 (AC-FT)	Peak Elevation:	92.3 (FT)

25-Year, 24-Hour Storm

Summary Results for Reservoir "Borrow Area 1 Basin"

Project: Ponds D and E Simulation Run: 25-Year Borrow Area 1
Reservoir: Borrow Area 1 Basin

Start of Run:	30Mar2015, 00:00	Basin Model:	BORROW AREA 1
End of Run:	01Apr2015, 23:00	Meteorologic Model:	25-yr Storm
Compute Time:	31Aug2015, 17:50:18	Control Specifications:	Control 1

Volume Units: ○ IN ◉ AC-FT

Computed Results

Peak Inflow:	59.2 (CFS)	Date/Time of Peak Inflow:	30Mar2015, 11:57
Peak Discharge:	14.9 (CFS)	Date/Time of Peak Discharge:	30Mar2015, 12:07
Inflow Volume:	3.1 (AC-FT)	Peak Storage:	3.3 (AC-FT)
Discharge Volume:	3.1 (AC-FT)	Peak Elevation:	92.9 (FT)

ATTACHMENT 4

FILTER DIAPHRAGM CALCULATIONS

SUBJECT:	Possum Point CCR Pond Closures - Sediment Basin for Borrow Area 1				
By:	SCHELAB	Date:	10/9/2015	Project No.	C150132.0
Chkd By:	BERKEME	Date:	10/14/2015	Sheet No.	

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Filter Diaphragm Design

References:

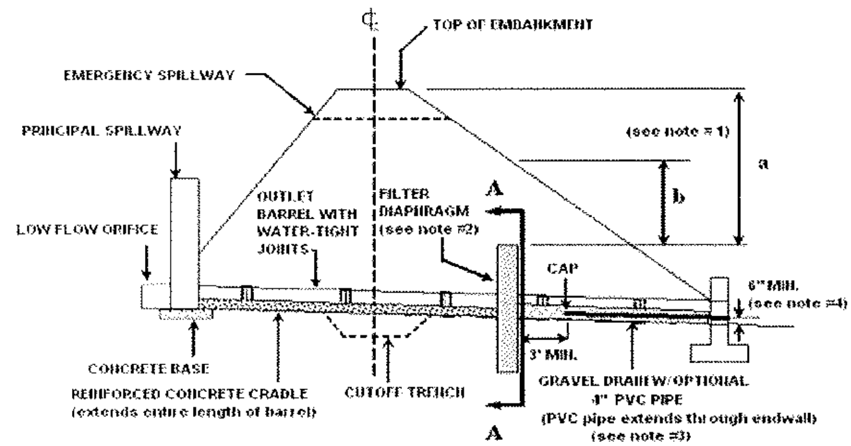
1) United States Department of Agriculture (USDA), Soil Conservation Service, Dimensioning of Filter-Drainage Diaphragms for Conduits According to TR-60", April 1985

2) United States Department of Agriculture (USDA), Soil Conservation Service, Supplement to Dimensioning of Filter-Drainage Diaphragms for Conduits According to TR-60", April 1985

3) National Engineering Handbook (NEH), Part 628 Dams, Chapter 45-Filter Diaphraghms, January 2007.

The following Figure, taken from the Pennsylvania Department of Environmental Protection "Erosion and Sediment Pollution Control Program Manual", March 2012 illustrates the criteria outlined in the above publications.

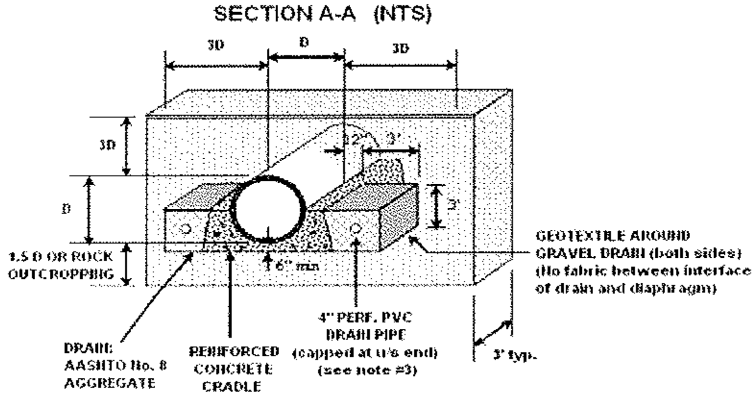
NTS



Notes:

1. Diaphragm should belocated d/s of embankment centerline and cutoff trench and u/s of a point where b = 0.5 a
2. Diaphragm should be constructed using a specially graded sand (Typically Type A concrete sand)
3. Optional drain pipe should have maximum 3/16" perforations if used in AASHTO No. 8 drain.
4. Outlet of drain should be located at least 6" above invert of outlet conduit.

SECTION A-A (NTS)



SUBJECT:	Possum Point CCR Pond Closures - Sediment Basin for Borrow Area 1				
By:	SCHELAB	Date:	10/9/2015	Project No.	C150132.0
Chkd By:	BERKEME	Date:	10/14/2015	Sheet No.	

Based on the above guidance, the following dimensions were selected for design

Conduit Diameter, D =	1.5 ft
Outside Diameter, Do =	1.50 ft
3Do =	4.5 ft
Top of Embankment Elevation =	96 ft
Invert of Principal Spillway Barrel at Section A-A=	86.9 ft
Top of Diaphragm at Section A-A=	92.9 ft
a=	3.1 ft
b min =	1.55 ft
b=	2 ft

(b is estimated from profile drawing)

TR-60 criteria states that b must be greater than or equal to 0.5a, so the diaphragm location meets the criteria.

Filter Diaphragm Outlet Design-Follows Example 2 From Reference 2

Find: Area of drain outlet

Construct Phreatic Line by Casagrande method

Top of Embankment Elevation (Settled), TE =	96 ft	
Top of Diaphragm El., TD=	92.9 ft	
Emergency Spillway Crest El., ES =	95 ft	(assumed 3' above PS
Principal Spillway Crest El., PS =	92 ft	
Toe of Upstream Embankment, TU =	90 ft	
Outlet Channel El., OC =	84 ft	
Embankment Side Slope (Upstream Side), Z1 =	3.0:1	
Embankment Side Slope (Downstream Side), Z2 =	3:01	
Embankment Top Width (Settled), TW =	6 ft	

m is the distance from where water surface intersects the slope to the toe of the embankment

1. 0.33m= 1/3 * [(PS-TU)*3] =	2 ft
m =	6 ft
2. d (estimated from plan view drawing)	66 ft
3. hy = PS-OC =	8.0 ft
4. Yo= (hy^2 +d^2)^0.5 - d =	0.48 ft

SUBJECT:	Possum Point CCR Pond Closures - Sediment Basin for Borrow Area 1				
By:	SCHELAB	Date:	10/9/2015	Project No.	C150132.0
Chkd By:	BERKEME	Date:	10/14/2015	Sheet No.	

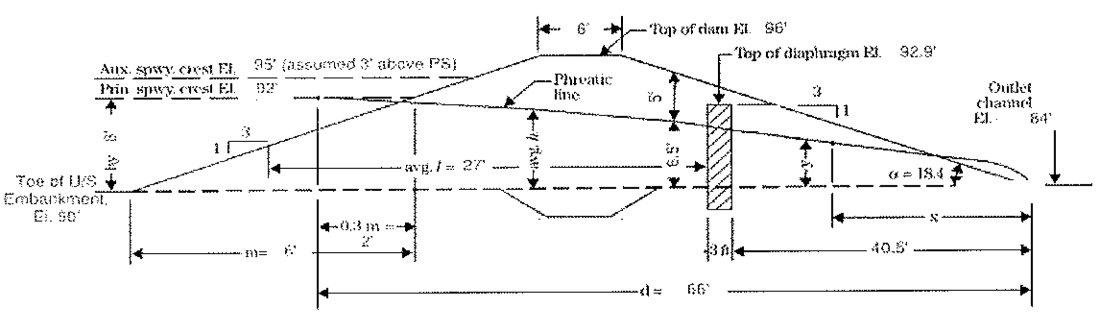
5. Calculate values of y corresponding to various values of x.

y=(2Yox + Yo^2)^0.5

x	y
10	3.1
40.5	6.3
43.5	6.5
66	8.0

6. Plot basic parabola as the phreatic line of the structure layout

Figure 45C–5 Structure layout and phreatic line computation



(210-VI-NEH, January 2007) 45C–7

Calculate Design Q for Filter Diaphragm

Use Darcy's Law, Q=KiA

1. Seepage Zone eqauls average height under phreatic line times width of diaphragm

Width of Diaphragm, W = 11 ft

A = (6.5+8.0)/2 x W = 76 sq ft

2. Hydraulic gradient, i=h/l

h = difference between emergency spillway and the height where the phreatic line hits the upstream face of the diaphragm.

h= ES- (OC + 6.5) = 4.5 ft

l= average seepage flow path from midpoint between the upstream toe of the embankment to the principal spillway crest, horizontally to the face of the diaphragm.

l= 27 ft (measured from drawing)

i= h/l = 0.167

3. Permeability coefficeint, K

K= 1 ft/day (taken from Ref 2, example 2)

For conservatism, assume embankment permeability is 100 times actual estimated permeability (0.01 ft/day)

SUBJECT:	Possum Point CCR Pond Closures - Sediment Basin for Borrow Area 1				
By:	SCHELAB	Date:	10/9/2015	Project No.	C150132.0
Chkd By:	BERKEME	Date:	10/14/2015	Sheet No.	

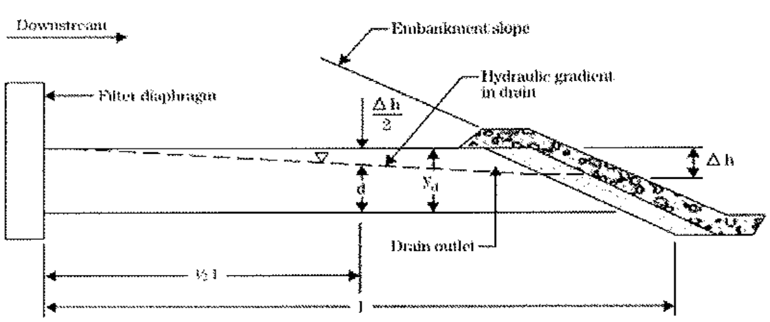
4. Design Q using Darcy's Law

Q=KiA= 12.7 cf/day

Calculate area of outlet for Filter Diaphragm

1. Consider the height of the drain as the height corresponding to the area calculated by Darcy's Law plus half of the hydraulic gradient in the drain.

Figure 45C–7 Filter diaphragm to the downstream toe

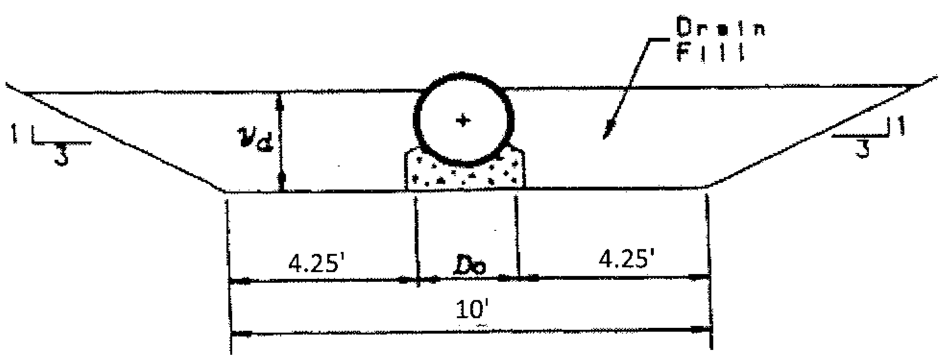


(210–VI–NEH, January 2007)

2. Calculate the average flow area of the drain outlet by Darcy's Law

GIVEN:

Q =	12.7 cf/day		
i=h/l = h/40.5			
l=	40.5		
Kf for drain outlet =	20 ft/day (From Reference 2 example)		
Q=KiA, A=Q/Kfi =	0.63 /i		
		a	3
yd=d+h/2		b	8.5
3d^2 + 8.5 d - A = 0	to solve quadratic equation:	c	A



OUTLET FOR DIAPHRAGM

SUBJECT: Possum Point CCR Pond Closures - Sediment Basin for Borrow Area 1
By: SCHELAB Date: 10/9/2015 Project No. C150132.0
Chkd By: BERKEME Date: 10/14/2015 Sheet No.

Test several h to find minimum Yd

h	i=h/40.5	A=.63/i		d1	d2	Yd
0.5	0.0123	51	688.78	2.96	-5.79	3.21
1.0	0.0247	26	380.51	1.83	-4.67	2.33
1.5	0.0370	17	277.76	1.36	-4.19	2.11
2.0	**0.0494**	**13**	**226.38**	**1.09**	**-3.92**	**2.09**
2.5	0.0617	10	195.56	0.91	-3.75	2.16
3.0	0.0741	9	175.00	0.79	-3.62	2.29
4.0	0.0988	6	149.32	0.62	-3.45	2.62
5.0	0.1235	5	133.90	0.51	-3.35	3.01

Use Yd= 2.10 ft

3. Area of drain outlet

A=3Yd^2+8.5Yd= 31.1 ft^2

POND D
PHASE II

'oint PS
32.00 -
lc.dwg

:
'd.)

3<Fill>

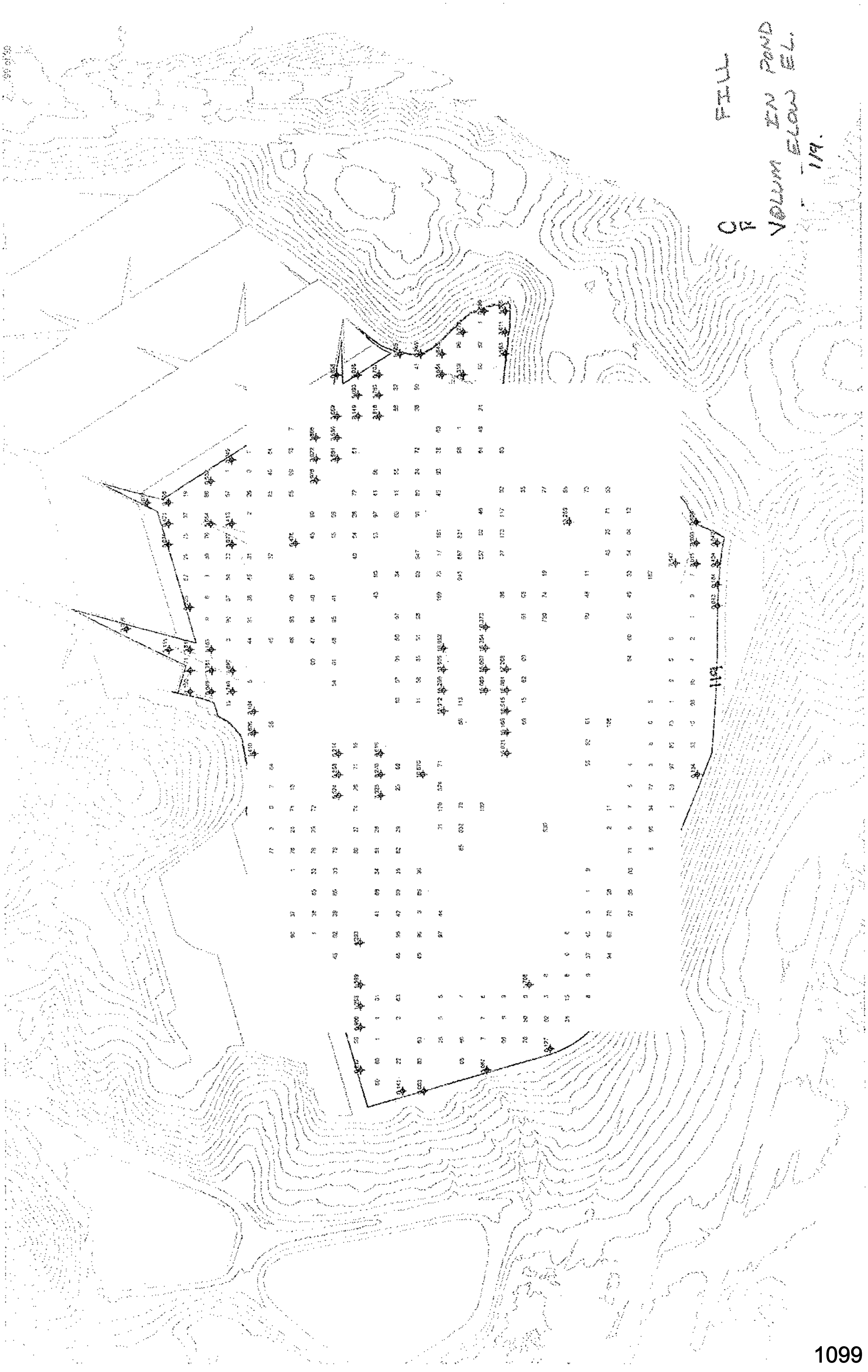
:
'd.)

3<Fill>

than 1.0

Volume Available Below El. 119 = 485,920 CY
= 301 AC-FT

PMF VOLUME = 293.1 AC-FT
(FINAL CONDITION)


OR FILL
VOLUM IN POND
BELOW EL.
119.

APPENDIX D
Culvert Design

APPENDIX D

TABLE OF CONTENTS:

SHEET*

*Appendix sheet numbers correspond to red numbers in the upper right hand corner of each page.

SUBJECT POSSUM POINT CCR POND CLOSURES
CULVERT E-1 DESIGN CALCULATIONS

BY SCHELAB DATE 8/23/2015 PROJ. NO. C150132.00

CHKD. BY BERKEME DATE 8/24/2015

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INTRODUCTION:
Water will be required to be culverted beneath the existing road and into the Sediment Basin in Pond E during the Possum Point CCB Pond Closure Project (Project). The culverts are designed to pass the anticipated peak flow rate from the 25-year, 24-hour storm event, considering the post construction / re-vegetated condition. Culvert performance will also be evaluated considering the temporary construction condition (worst case runoff) as well as the Probable Maximum Flood (PMF).

This calculation set will size culverts based on peak flows determined from the Site Hydrology calculations. Analysis will utilize the Federal Highway Administration's program, HY-8 (Version 7.2).

METHODOLOGY:
The approximate locations of culverts are included on the plan drawings provided with this permit package. From these locations, estimates were made as to the ground surface elevations at culvert inlet and outlet locations as well as roadway elevations.

ATTACHMENTS:

1. HY-8 Calculations
2. Drawing 715932 - Site Plan – Ash Pond D Expansion, Virginia Power, 4/16/86.

REQUIREMENTS / ASSUMPTIONS:

- Minimum cover above culverts is 1 ft.
- Circular culverts will be corrugated exterior, smooth interior HDPE.
- Culvert outlet conditions are set using the receiving channel (E-1) dimensions.

CULVERT DESIGN:
Culvert E1 conveys runoff from the Pond D outlet channel and Metals Pond Diversion C beneath an existing road and discharges to Channel E-1. Design flow to the culvert will be estimated assuming the post development condition for Ponds D and E. The culvert will be assessed for the 25-year design event, the overtopping event, and the Probable Maximum Flood (PMF).

SUBJECT POSSUM POINT CCR POND CLOSURES
CULVERT E-1 DESIGN CALCULATIONS

BY SCHELAB DATE 8/23/2015 PROJ. NO. C150132.00

CHKD. BY BERKEME DATE 8/24/2015

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HY-8 Input and Output is included as Attachment 1 and is summarized below:

Design Flow (25 Year, 24 Hour Post Development) = 223 cfs

PMF Flow = 1,782 cfs

Culvert Length	=	88 ft
Culvert Slope	=	0.0125 ft/ft
Culvert Diameter	=	3.5 ft
Number of Barrels	=	3.0

Inlet Invert Elevation	=	49 ft
Outlet Invert Elevation	=	46 ft
Roadway Elevation	=	55 ft
Minimum Cover Provided	=	2 ft

Outlet Conditions

Receiving Channel	=	*E-1*
Channel Depth	=	*4.0 ft*
Side Slopes	=	*2H:1V*
Bottom Width	=	*15 ft*
Manning's "n"	=	*0.024*
Downstream Channel Slope	=	*0.07*

Culvert Performance:

25-year Design Headwater	=	54.4 ft
Overtopping Flow Rate	=	244 cfs
PMF Design Headwater	=	56.8 ft

The selected culverts are anticipated to pass the 25-year storm event without overtopping the road, once the site is developed. The culverts are anticipated to overtop the road at a flow of 244 cfs, which corresponds to approximately a 5-year storm event in the worst case, temporary runoff condition.

The culvert is anticipated to pass approximately 14% of the PMF flow rate, with the rest overtopping the road. HY-8 modeling indicates a headwater elevation of 1.8 feet to pass the PMF over the road. This estimated headwater will not reach the elevation of the toe of the existing dam fill (~ 86 feet), as shown on the construction drawings for the dam (Attachment 2).

SUBJECT POSSUM POINT CCR POND CLOSURES
CULVERT E-1 DESIGN CALCULATIONS

BY SCHELAB DATE 8/23/2015 PROJ. NO. C150132.00

CHKD. BY BERKEME DATE 8/24/2015

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OUTLET PROTECTION DESIGN:

TAILWATER DEPTH:
The depth of the tailwater immediately below the pipe or channel outlet is taken from the HY-8 model, and it will determine if there is a minimum or maximum tailwater condition.

D_t = depth of tailwater = 0.93 ft (tailwater depth from HY-8)
D_p = Diameter of the outlet pipe = 3.5 ft

D_t (0.93) < ½ d_p (1.75 ft) $\longrightarrow$ Minimum tailwater condition

APRON SIZE:
The figure on the following sheet will be used to size the apron. Because the apron discharges into a proposed channel, the width of the apron will match that of the channel.

Apron Length = 26'

Rock size = VDOT Class I (D_{50} = 1.1 ft)

SUBJECT POSSUM POINT CCR POND CLOSURES

CULVERT E-1 DESIGN CALCULATIONS

BY SCHELAB DATE 8/23/2015 PROJ. NO. C150132.00

CHKD. BY BERKEME DATE 8/24/2015

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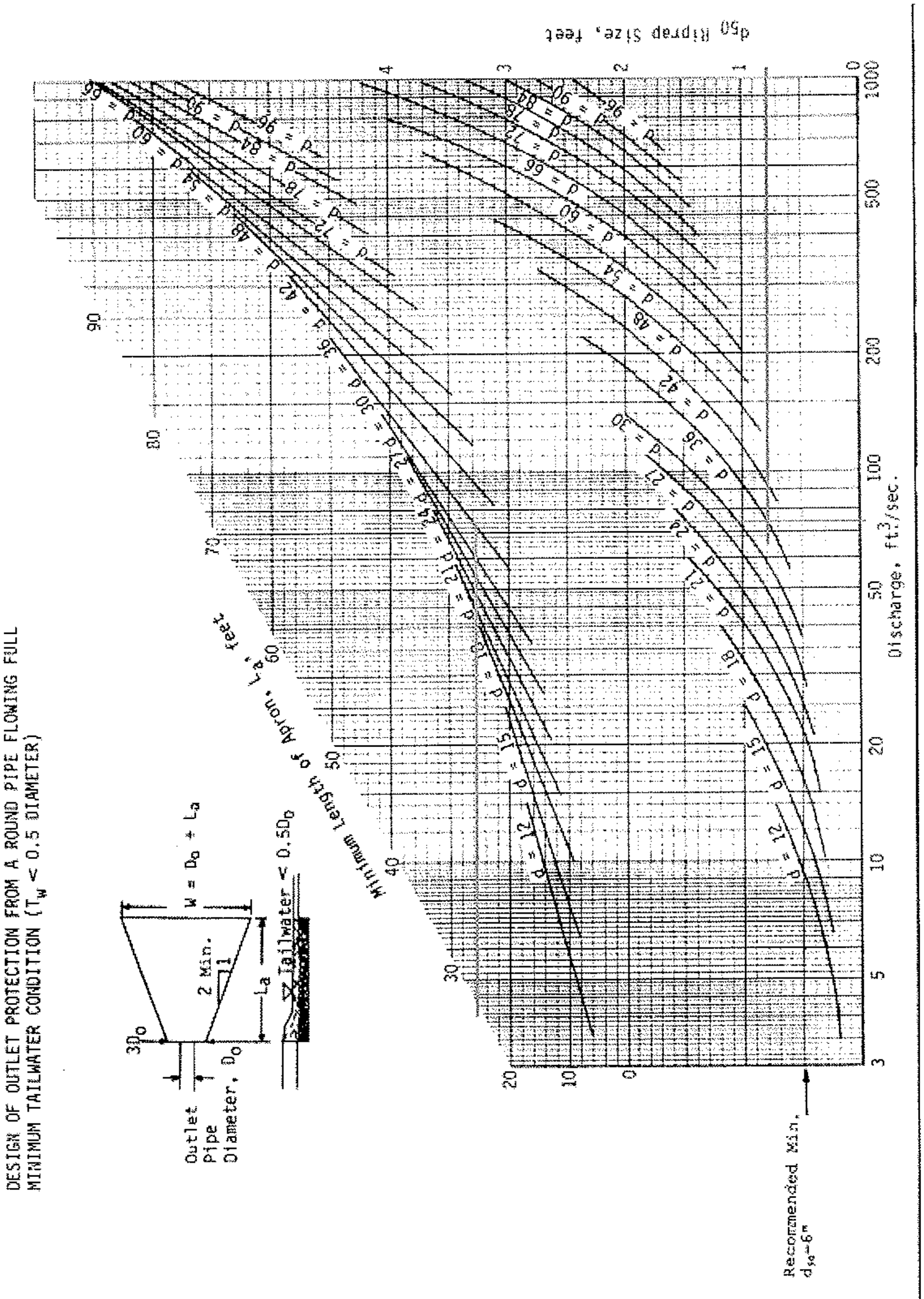

SUBJECT POSSUM POINT CCR POND CLOSURES
CULVERT E-1 DESIGN CALCULATIONS
BY SCHELAB DATE 8/23/2015 PROJ. NO. C150132.00
CHKD. BY BERKEME DATE 8/24/2015

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ATTACHMENT 1

HY8 CALCULATIONS

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0 cfs

Design Flow: 223 cfs

Maximum Flow: 1782 cfs

Table 1 - Summary of Culvert Flows at Crossing: Culvert E-1

Headwater Elevation (ft)	Total Discharge (cfs)	3-3.5' Discharge (cfs)	Roadway Discharge (cfs)	Iterations
49.00	0.00	0.00	0.00	1
53.28	178.20	178.20	0.00	1
54.40	223.00	223.00	0.00	1
55.59	534.60	262.00	272.26	6
55.81	712.80	268.63	443.16	4
56.01	891.00	274.34	616.01	4
56.19	1069.20	279.42	789.33	4
56.36	1247.40	284.05	963.14	4
56.52	1425.60	288.30	1136.23	3
56.67	1603.80	292.31	1310.97	3
56.82	1782.00	296.08	1485.74	3
55.00	243.66	243.66	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert E-1

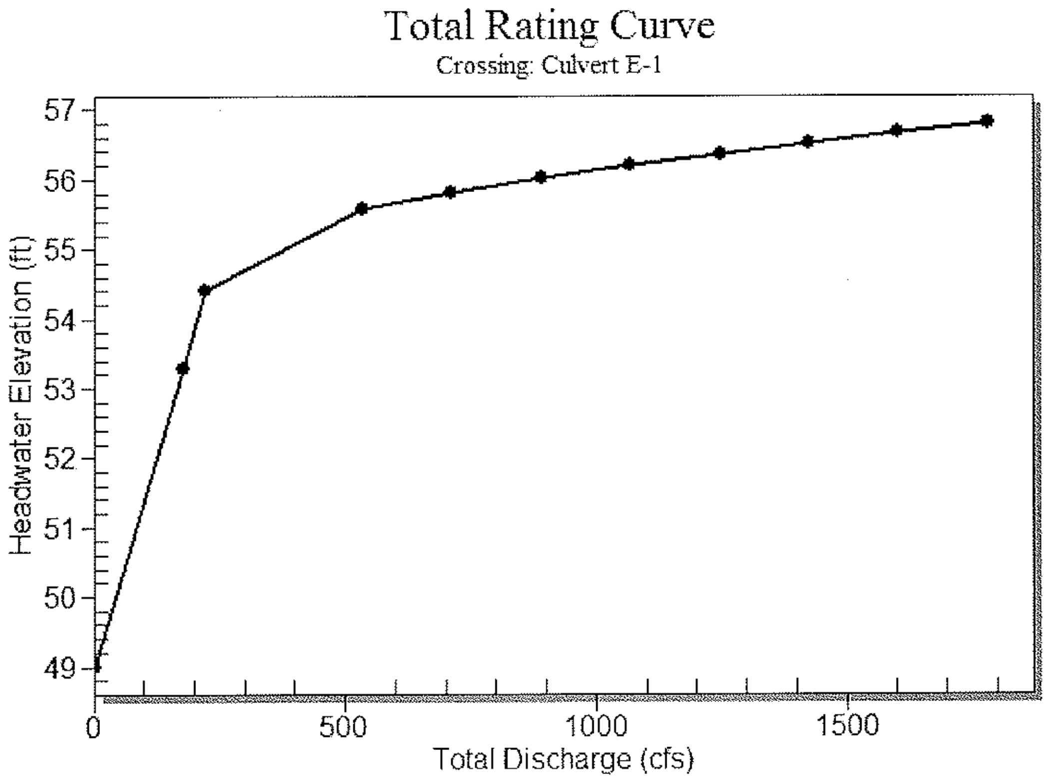


Table 2 - Culvert Summary Table: 3-3.5'

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	49.00	0.000	0.000	0-NF	0.000	0.000	2.000	0.000	0.000	0.000
178.20	178.20	53.28	4.284	1.196	5-S2n	1.300	2.412	1.473	0.811	15.431	13.211
223.00	223.00	54.40	5.397	2.094	5-S2n	1.466	2.696	1.690	0.926	16.159	14.294
534.60	262.00	55.59	6.586	3.530	5-S2n	1.610	2.904	1.868	1.539	16.718	19.222
712.80	268.63	55.81	6.811	3.958	5-S2n	1.632	2.935	1.898	1.814	16.812	21.099
891.00	274.34	56.01	7.010	4.338	5-S2n	1.652	2.961	1.923	2.058	16.892	22.646
1069.20	279.42	56.19	7.192	4.683	5-S2n	1.669	2.984	1.945	2.280	16.962	23.972
1247.40	284.05	56.36	7.361	5.001	5-JS1f	1.685	3.004	3.500	2.485	10.307	25.134
1425.60	288.30	56.52	7.519	5.299	5-JS1f	1.700	3.022	3.500	2.676	10.462	26.174
1603.80	292.31	56.67	7.671	5.579	5-JS1f	1.713	3.038	3.500	2.856	10.607	27.117
1782.00	296.08	56.82	7.817	5.846	5-JS1f	1.726	3.053	3.500	3.025	10.744	27.981

****

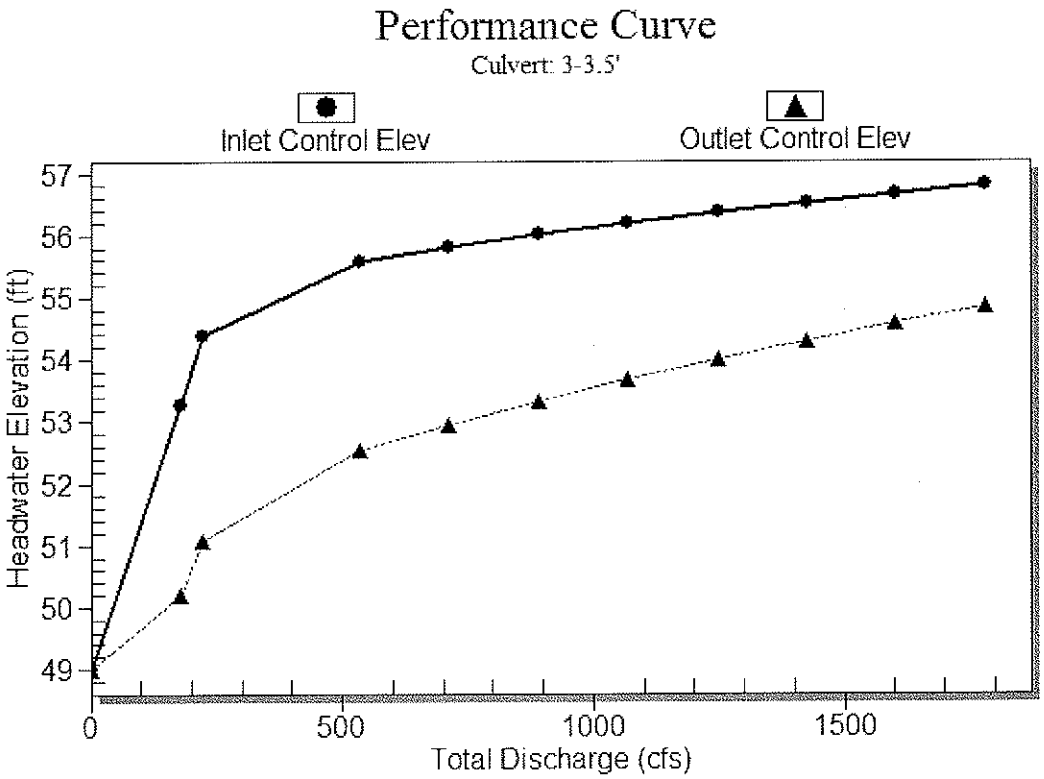
Straight Culvert

Inlet Elevation (invert): 49.00 ft, Outlet Elevation (invert): 46.00 ft

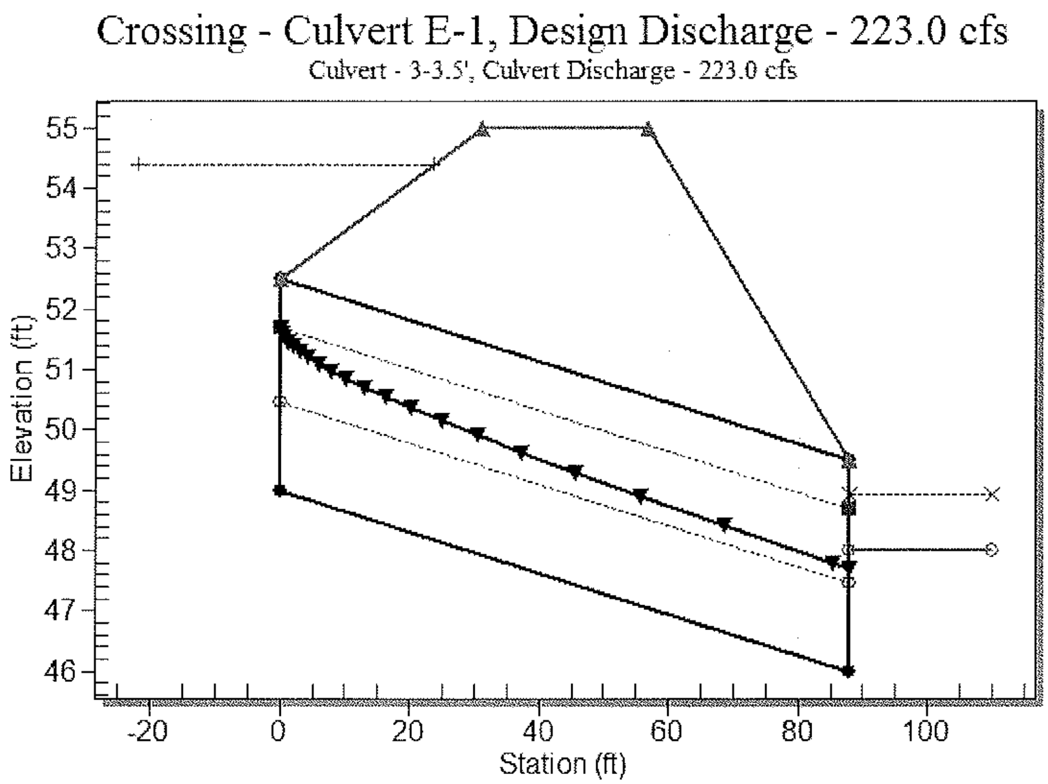
Culvert Length: 88.05 ft, Culvert Slope: 0.0341

****

Culvert Performance Curve Plot: 3-3.5'



Water Surface Profile Plot for Culvert: 3-3.5'



Site Data - 3-3.5'

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 49.00 ft

Outlet Station: 88.00 ft

Outlet Elevation: 46.00 ft

Number of Barrels: 3

Culvert Data Summary - 3-3.5'

Barrel Shape: Circular

Barrel Diameter: 3.50 ft

Barrel Material: Smooth HDPE

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: Culvert E-1)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	48.00	0.00	0.00	0.00	0.00
178.20	48.81	0.81	13.21	3.54	2.71
223.00	48.93	0.93	14.29	4.04	2.76
534.60	49.54	1.54	19.22	6.72	2.95
712.80	49.81	1.81	21.10	7.92	3.02
891.00	50.06	2.06	22.65	8.99	3.07
1069.20	50.28	2.28	23.97	9.96	3.11
1247.40	50.49	2.49	25.13	10.86	3.14
1425.60	50.68	2.68	26.17	11.69	3.17
1603.80	50.86	2.86	27.12	12.47	3.19
1782.00	51.03	3.03	27.98	13.21	3.22

Tailwater Channel Data - Culvert E-1

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 15.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0700

Channel Manning's n: 0.0240

Channel Invert Elevation: 48.00 ft

Roadway Data for Crossing: Culvert E-1

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 200.00 ft

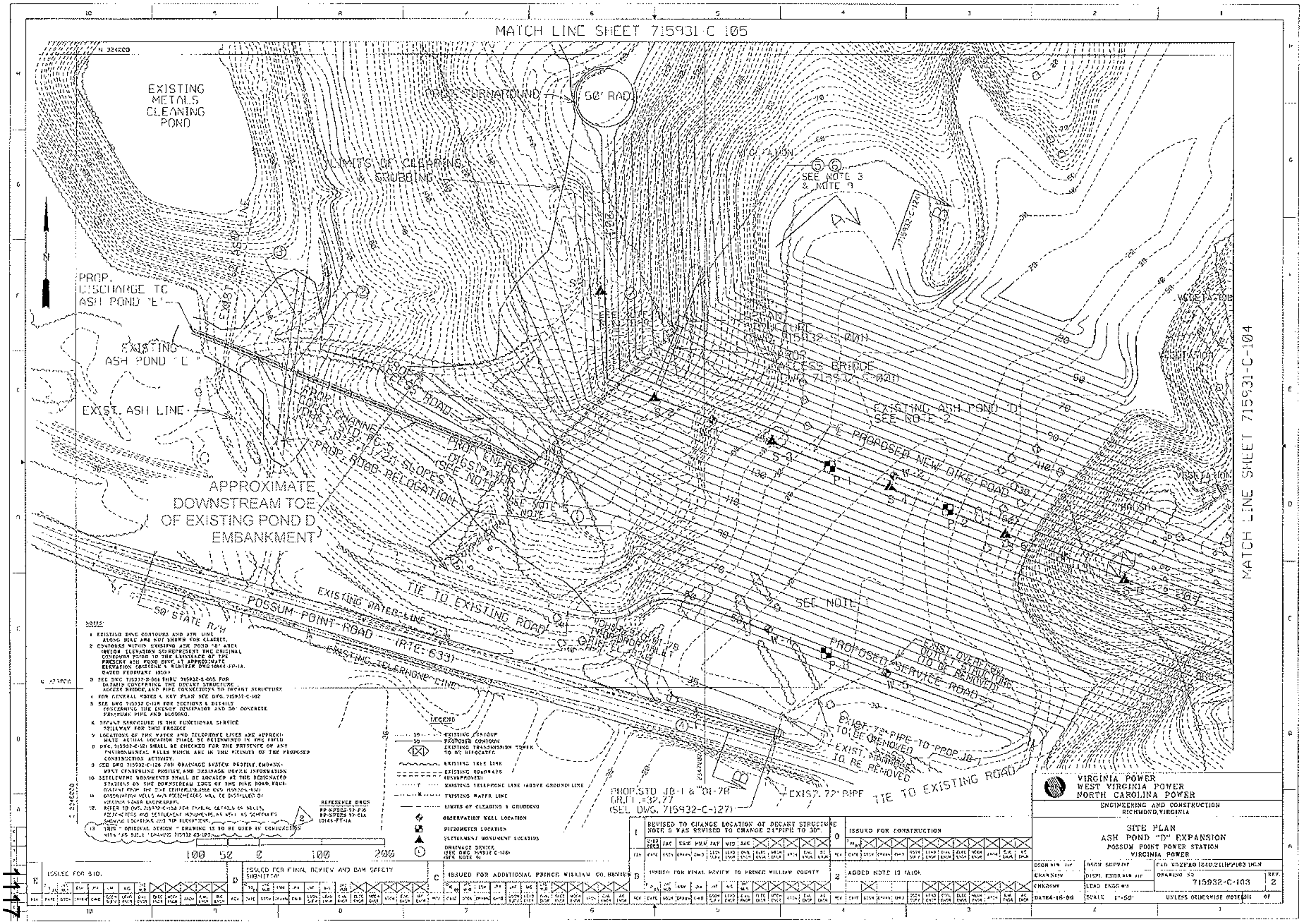
Crest Elevation: 55.00 ft

Roadway Surface: Paved

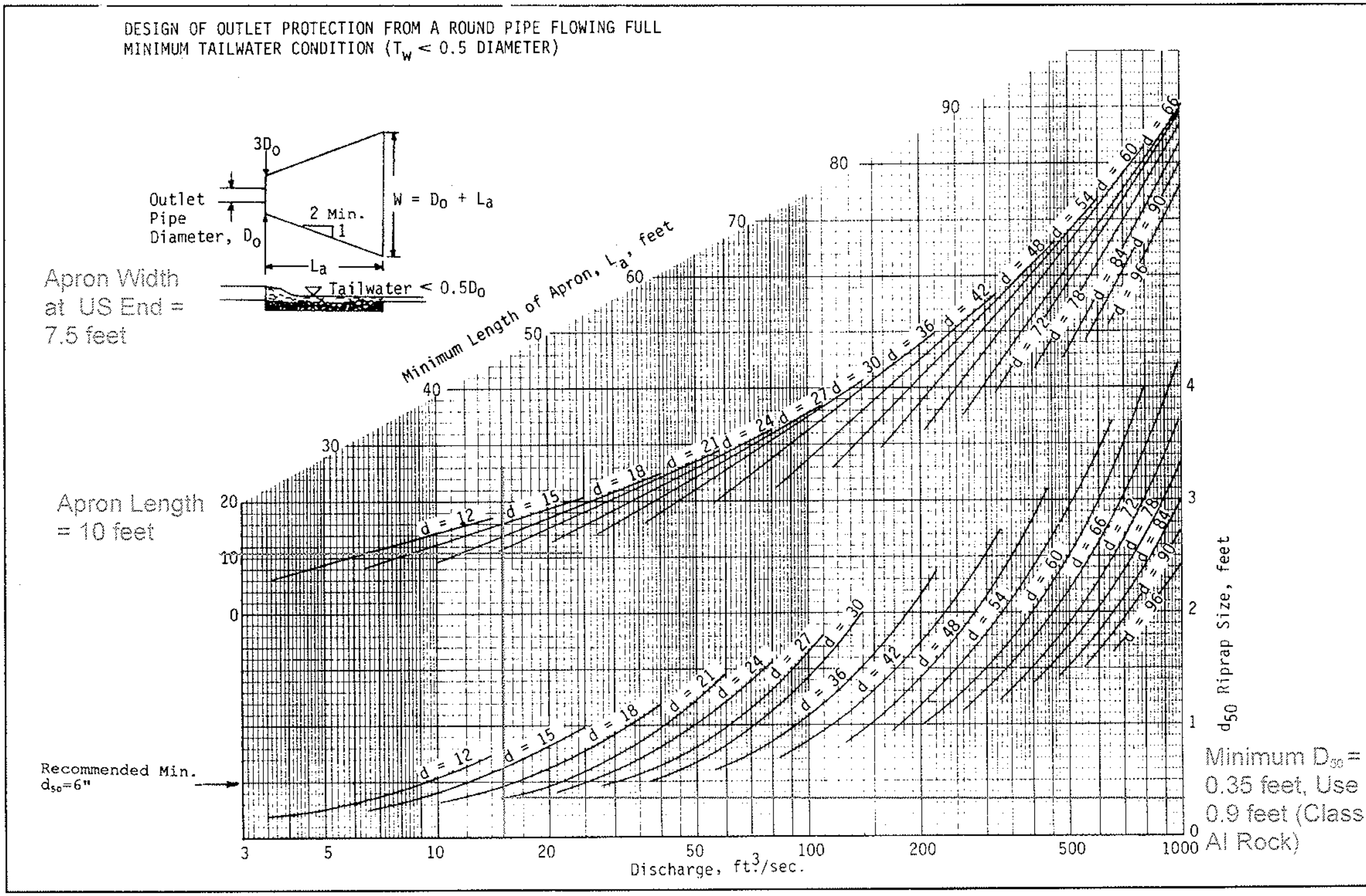
Roadway Top Width: 26.00 ft

ATTACHMENT 2

POND D CONSTRUCTION DRAWING



MATCH LINE SHEET 715931-C 105
MATCH LINE SHEET 715931-C-104
EXISTING METALS CLEANING POND
PROP. TURNAROUND
50' RAD
LIMITS OF CLEARING & GRUBBING
SEE NOTE 3 & NOTE 9
PROP. DISCHARGE TO ASH POND "E"
EXISTING ASH POND "E"
EXIST. ASH LINE
APPROXIMATE DOWNSTREAM TOE OF EXISTING POND D EMBANKMENT
PROP. ACCESS ROAD
PROP. ROAD RELOCATION
PROP. ENERGY DISSIPATOR (SEE NOTE)
ACCESS BRIDGE
EXISTING ASH POND "D" SEE NOTE 2
PROPOSED NEW DIKE ROAD
TIE TO EXISTING ROAD
EXISTING WATER LINE
POSSUM POINT ROAD (RTE. 633)
EXISTING TELEPHONE LINE
50' STATE R/W
SEE NOTE
PROPOSED SERVICE ROAD
EXIST. OVERFLOW OUTLET STRUCTURE TO BE REMOVED
EXIST. 72" PIPE TO PROP. JB-1 TO BE REMOVED
EXIST. STANDPIPE TO BE REMOVED
EXIST. 72" RCPP
PROP. STD JB-1 & "01-78" GR.IT. =32.77 (SEE DWG. 715932-C-127)
NOTES:
LEGEND
REFERENCE DWGS
100 50 0 100 200
ISSUED FOR BID.
ISSUED FOR FINAL REVIEW AND DAM SAFETY SUBMITTAL
ISSUED FOR ADDITIONAL PRINCE WILLIAM CO. REVIEW
ISSUED FOR FINAL REVIEW TO PRINCE WILLIAM COUNTY
REVISED TO CHANGE LOCATION OF DECANT STRUCTURE NOTE 5 WAS REVISED TO CHANGE 24" PIPE TO 30"
ISSUED FOR CONSTRUCTION
ADDED NOTE 13 (ALO)
VIRGINIA POWER
WEST VIRGINIA POWER
NORTH CAROLINA POWER
ENGINEERING AND CONSTRUCTION
RICHMOND, VIRGINIA
SITE PLAN
ASH POND "D" EXPANSION
POSSUM POINT POWER STATION
VIRGINIA POWER
715932-C-103
REV. 2
SCALE 1"=50'
UNLESS OTHERWISE NOTED



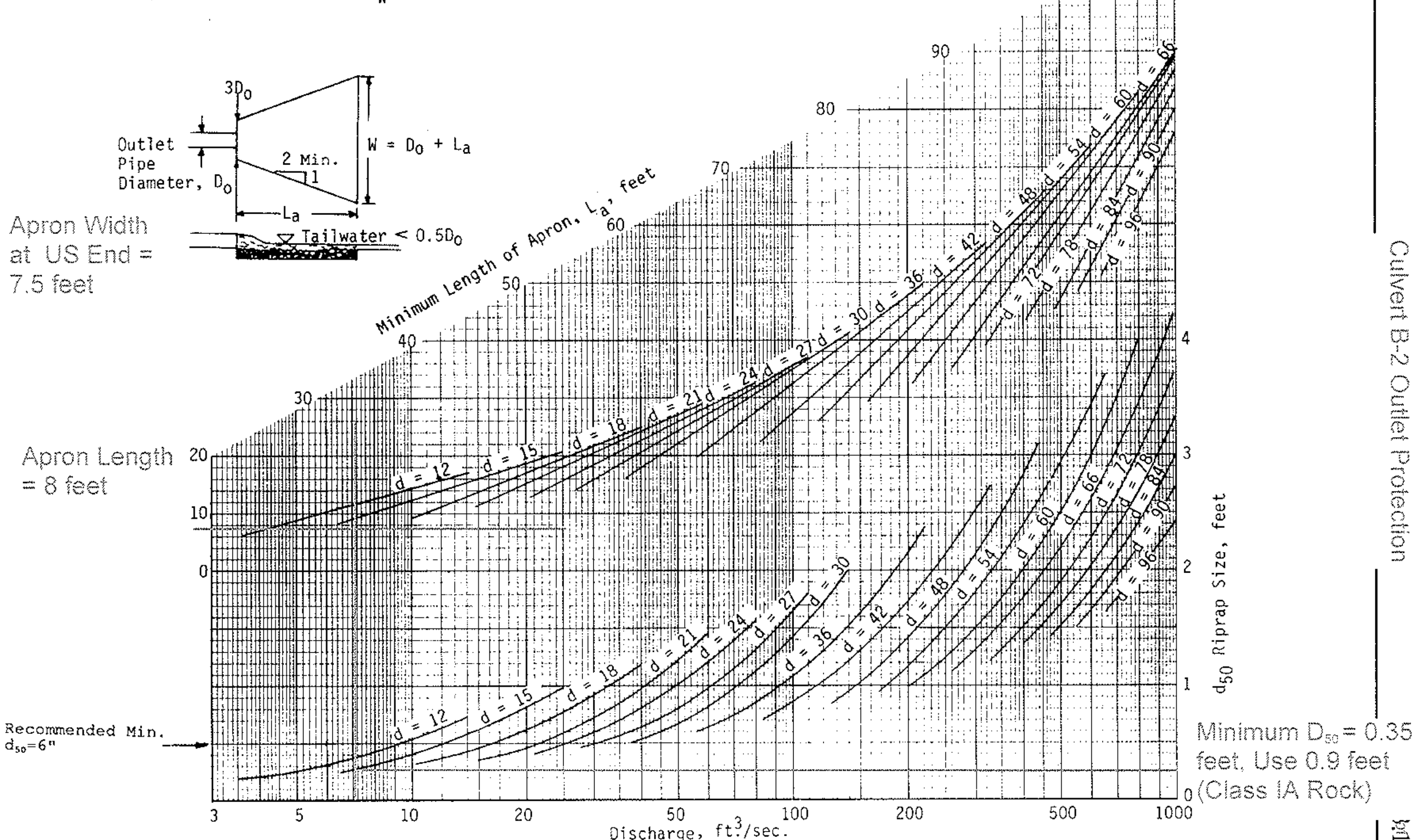
1992

Culvert B-1 Outlet Protection

1/3/18

Culvert B-2 Outlet Protection

DESIGN OF OUTLET PROTECTION FROM A ROUND PIPE FLOWING FULL
MINIMUM TAILWATER CONDITION (T_w < 0.5 DIAMETER)



Source: USDA-SCS

Plate 3.18-3

TABLE 3.19-B

GRADED RIPRAP - DESIGN VALUES

Riprap Class	D_{15} Weight (lbs.)	Mean D_{15} Spherical Diameter (ft.)	Mean D_{50} Spherical Diameter (ft.)
Class AI	25	0.7	0.9
Class I	50	0.8	1.1
Class II	150	1.3	1.6
Class III	500	1.9	2.2
Type I	1,500	2.6	2.8
Type II	6,000	4.0	4.5

CULVERT B1 and B2

Source: VDOT Drainage Manual

The designer, after determining the riprap size that will be stable under the flow conditions, shall consider that size to be a minimum size and then, based on riprap gradations actually available in the area, select the size or sizes that equal or exceed the minimum size. The possibility of damage by children shall be considered in selecting a riprap size, especially if there is nearby water or a gully in which to toss the stones.

Thickness

The minimum thickness of the riprap layer shall be 2 times the maximum stone diameter, but not less than 6 inches.

Quality of Stone

Stone for riprap shall consist of field stone or rough unhewn quarry stone of approximately rectangular shape. The stone shall be hard and angular and of such quality that it will not disintegrate on exposure to water or weathering and it shall be suitable in all respects for the purpose intended. The specific gravity of the individual stones shall be at least 2.5.

Rubble concrete may be used provided it has a density of at least 150 pounds per cubic foot, and otherwise meets the requirement of this standard and specification.

APPENDIX E
VDOT Culvert Evaluation

APPENDIX E

TABLE OF CONTENTS:

*Appendix sheet numbers correspond to red numbers in the upper right hand corner of each page.

SUBJECT POSSUM POINT CCR POND CLOSURES
EVALUATION OF POSSUM POINT ROAD CULVERT

BY SCHELAB DATE 8/23/2015 PROJ. NO. C150132.00

CHKD. BY BERKEME DATE 8/24/2015

gai consultants

PURPOSE:
Evaluate potential impacts to water surface elevations upstream of the Virginia Department of Transportation (VDOT) culverts beneath Possum Point Road and assess compliance with applicable design criteria.

METHODOLOGY:
Potential impacts to water surface elevations are assessed considering Federal Emergency Management Agency (FEMA) floodplain regulations and VDOT criteria for culvert crossings.

Published FEMA information is reviewed to identify the factors governing the regulatory water surface elevations. Hydrologic and hydraulic modeling is utilized to estimate discharge from the closure site and undisturbed areas and culvert performance.

REFERENCES:

1. FEMA Flood Insurance Rate Map (FIRM) No. 51153C0316E for Prince William County, VA, panel 316 of 328, August 2015.
2. FEMA Flood Insurance Study (FIS) for Prince William County, VA and Incorporated Areas, August 2013.
3. USGS, Scientific Investigations Report 2011-5144, Peak Flow Characteristics of Virginia Streams, 2011.
4. USGS, Scientific Investigations Report 207-5162, Bankfull Regional Curves for Stream in the Non-Urban, Non-Tidal Coastal Plain Physiographic Province, Virginia and Maryland, 2007.
5. Schnabel Engineering, Dam Breach Analysis and Emergency Preparedness Plan Supporting Documentation, April 2011.
6. VDOT Functional Classification Map for Prince William County, VA, 2005.
7. VDOT Drainage Manual, July 2014.

ATTACHMENTS:

1. Reference Material
2. Quantico Creek Tributary Hydrologic Calculations
3. HY-8 Calculations
4. HEC-HMS Routing

DESIGN CRITERIA:

1. 100-year water surface elevation upstream of the Possum Point Road Culvert shall not be increased above the existing regulatory elevations.

2. Possum Point Road Culvert must be able pass 10-year runoff without inundation of Possum Point Road (References 6 and 7).

ANALYSIS:

FEMA Data Review

Runoff from the closed ponds is planned to discharge into a tributary of Quantico Creek. The tributary and Quantico Creek have both been studied by FEMA and Base Flood Elevations (BFE's) have been established. Attachment 1 shows the FIRM with the approximate location of the VDOT culverts and the proposed facility discharge location.

The BFE's on Quantico Creek and the tributary have been developed by FEMA considering a stillwater elevation (governed by water levels in the Potomac River) as well as estimates of wave heights.

As shown on Attachment 2, the BFE's and mapping in the vicinity of the Project are based on information from transect 15. As shown on Attachment 3, Transect 15 has an estimated 100-year stillwater elevation of 6.9 feet, and a significant wave height of 3.1 feet. This corresponds to the established BFE of 10 feet within the limits of moderate wave action; and the BFE of 8 feet beyond the limits of moderate wave action, as indicated on the FIRM.

Project survey and mapping indicates that the low point of Possum Point Road at the culvert crossing is at approximately 14 feet. As such, Possum Point Road is not anticipated to be inundated during a 100-year event.

Thus, the FEMA estimated BFE upstream of the Possum Point Road *Culverts is not governed by backwater due to the culverts*, but rather by water surface elevations in the Potomac River.

Hydrologic and Hydraulic Modeling

Flows from the closure site are as presented in the hydrologic calculations for the overall site development. Flows into the tributary upstream of the proposed discharge are estimated in this calculation using regression equations developed for the coastal region of Virginia as well as using the TR-55 methodology.

The tributary is separated from Quantico Creek by Possum Point Road and is connected hydraulically via two (2) six (6) foot diameter culverts (VDOT culverts). Under normal conditions, water surface elevations on the upstream and downstream ends are the culvert are equal.

To model performance of the culvert for various runoff events, the tributary upstream of Possum Point Road is represented in the HEC-HMS model as a storage basin with culvert outlets. A stage discharge curve is developed for the culverts using the Federal Highway Administration program HY-8, version 7.3.

Hydrology (Attachment 2):

Excluding the closure site, which drains approximately 231 acres in the post construction condition, the tributary to Possum Point Road has a drainage area of approximately 628 acres. As an initial estimate of peak flows from this area, the regression equations presented in Reference 3 were used, yielding the following peak flow rates:

VA Regression Equation Estimated Flows:

10-year storm	=	126 cfs
100-year storm	=	376 cfs

In order to incorporate the contribution from this drainage area into the HMS model, The SCS TR-55 method was utilized. The TR-55 modeling estimated peak flows to be higher than those of the regression with, which is typical of the method when applied to natural watersheds. The higher TR-55 flows will be used in this analysis for a conservative analysis.

TR-55 Method Estimated Flows

10-year storm	=	141 cfs
100-year storm	=	741 cfs

HY-8 Culvert Analysis (Attachment 3):

The culverts were modeled based on information presented in the 2011 Dam Breach analysis report, which was based on November 2010 survey information provided by Dominion (Reference 5).

HEC-HMS Modeling (Attachment 4):

To evaluate the hydraulic performance of the VDOT culverts with regard to the increased runoff from the closure site, a normal water surface elevation was assumed in Quantico Creek. Based on Reference 2, the 10-year Stillwater elevation in Quantico Creek is 5.4-feet. For this analysis, normal water surface elevation is assumed to be 5-feet, which corresponds to survey data collected for the project.

HEC-HMS was utilized to determine peak water surface elevations in the tributary using this normal water surface elevation of 5 feet as the tailwater condition for the culverts as well as the initial elevation of the reservoir upstream of the culverts,

RESULTS:

The HEC-HMS modeling estimated the following water surface elevations upstream of the VDOT culverts for the 10-year and 100-year design events:

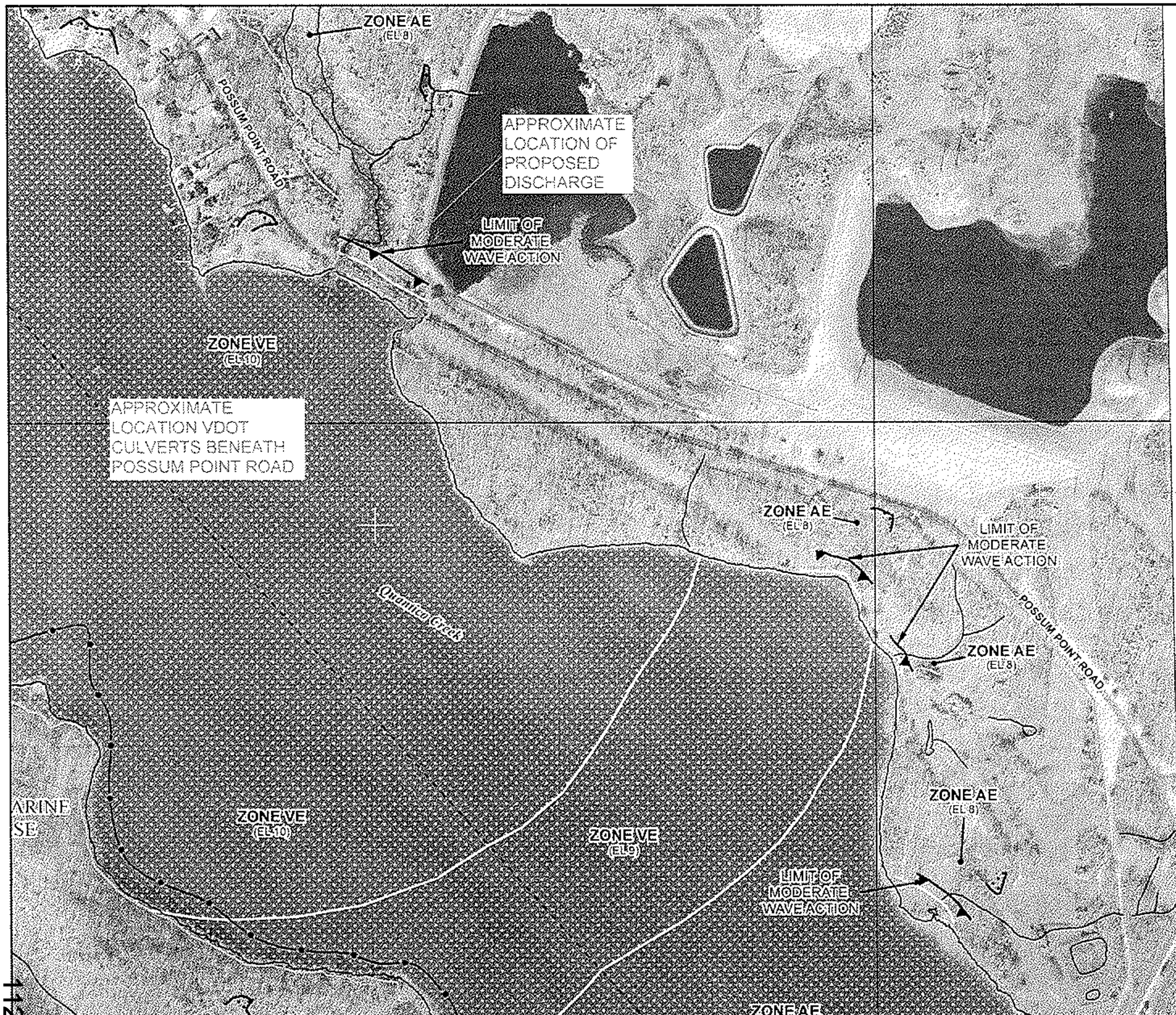
10-year W.S.E.	=	5.3 feet
100-year W.S.E.	=	7.9 feet

Modeling of the Possum Point Road Culvert indicates that the increased runoff from the closure site is not anticipated to cause 100-year water surface elevations that exceed those published by FEMA upstream of the culvert (8-10 feet). As such, the project complies with floodplain management criteria.

The modeling also indicates that Possum Point Road will not be overtopped during its design event (10-year storm). Therefore, the Project complies with VDOT design criteria.

ATTACHMENT 1

Reference Information



ional Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'

50 0 500 1000 FEET

METERS

NFIP

PANEL 0316E

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

PRINCE WILLIAM COUNTY, VIRGINIA
AND INCORPORATED AREAS

PANEL 316 OF 328

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
DUMFRIES, TOWN OF	510120	0316	E
PRINCE WILLIAM COUNTY	510119	0316	E

Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.

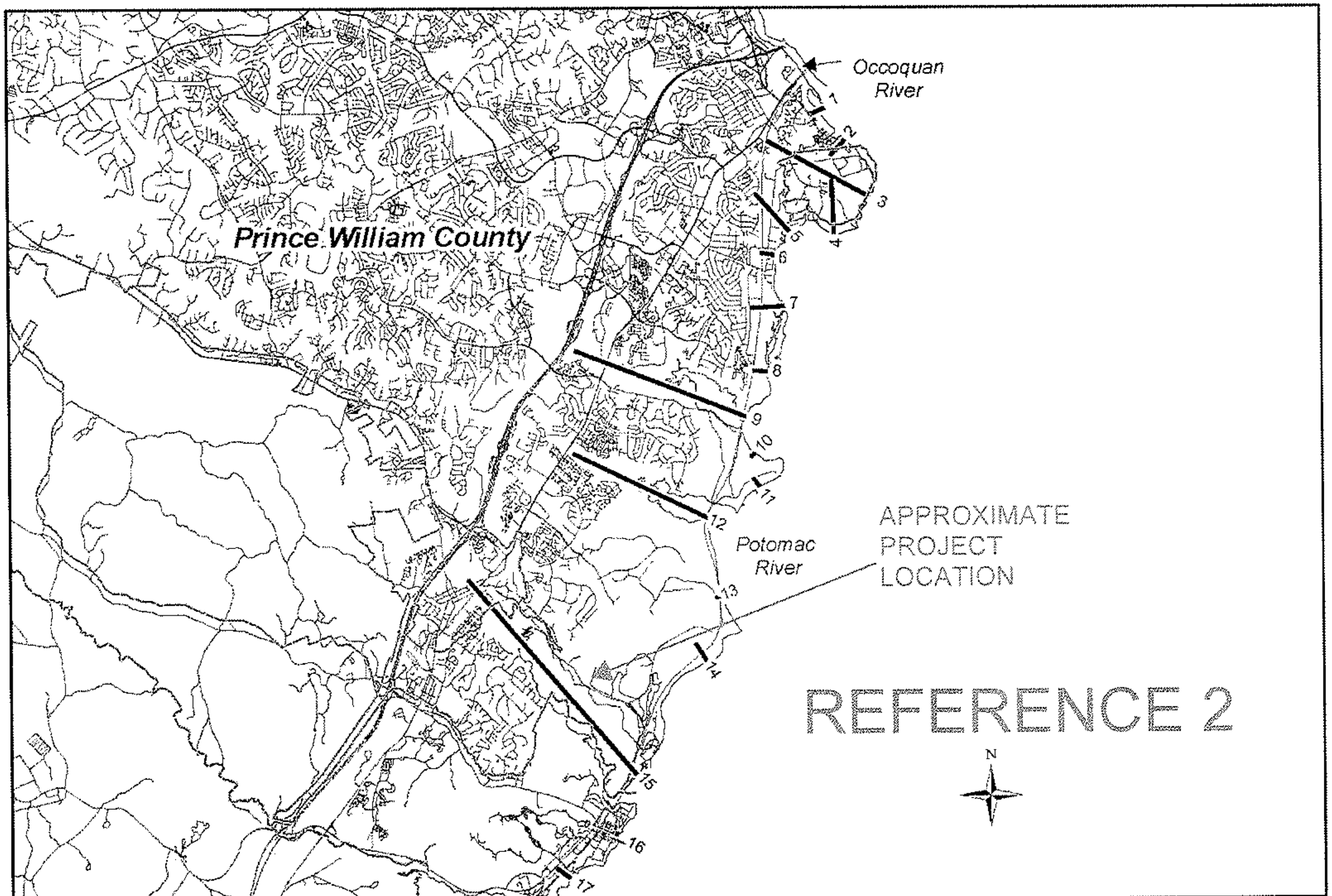
MAP NUMBER
51153C0316E

MAP REVISED
AUGUST 3, 2015

Federal Emergency Management Agency

REFERENCE 1

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov



0 0.75 1.5 3 4.5 6 Miles

FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

PRINCE WILLIAM COUNTY, VA
AND INCORPORATED AREAS

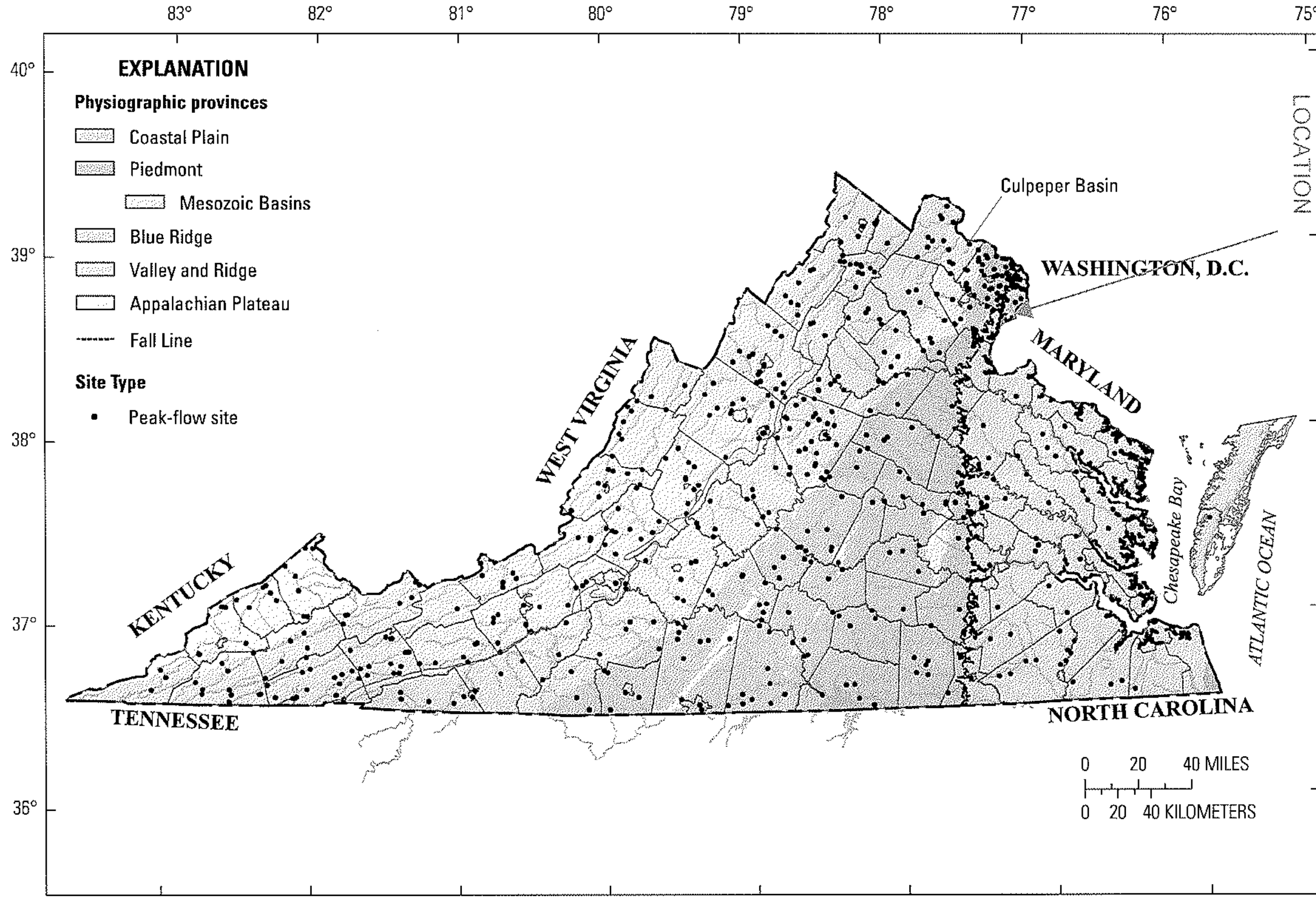
TRANSECT LOCATION MAP

REFERENCE 2

Table 8 – Transect Data - continued								
		Starting Wave Conditions for the 1% Annual Chance			Starting Stillwater Elevations (feet NGVD 29)			
Flood Source	Transect	Coordinates	Significant Wave Height H_s (ft)	Peak Wave Period T_p (sec)	10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
POTOMAC RIVER	12	N 38.582249 W -77.264711	3.1	3.1	5.5	6.6	6.9	9.1
POTOMAC RIVER	13	N 38.567441 W -77.261679	3.0	3.3	5.5	6.6	6.9	8.9
POTOMAC RIVER	14	N 38.554944 W -77.265469	3.0	3.5	5.5	6.5	6.9	8.8
POTOMAC RIVER	15	N 38.533194 W -77.282823	3.1	3.8	5.4	6.6	6.9	8.7
POTOMAC RIVER	16	N 38.521753 W -77.287380	3.3	4.0	5.4	6.6	6.9	8.7
POTOMAC RIVER	17	N 38.513291 W -77.299167	3.4	4.1	5.4	6.6	6.9	8.6

Areas of coastline subject to significant wave attack are referred to as coastal high hazard zones. The USACE has established the 3-foot breaking wave as the criterion for identifying the limit of coastal high hazard zones (Reference 15). The 3-foot wave has been determined the minimum size wave capable of causing major damage to conventional wood frame of brick veneer structures. The one exception to the 3-foot wave criteria is where a primary frontal dune exists. The limit the coastal high hazard area then becomes the landward toe of the primary frontal dune or where a 3-foot or greater breaking wave exists, whichever is most landward.

The coastal high hazard zone is depicted on the FIRM as Zone VE, where the delineated flood hazard includes wave heights equal to or greater than 3 feet. Zone AE is depicted on the FIRM where the delineated flood hazard includes wave heights less than 3 feet. A depiction of a sample transect which illustrates the relationship between the stillwater elevation, the wave crest elevation, and the ground elevation profile, and how the Zones VE and AE are mapped is shown in Figure 2, "Typical Transect Schematic".



Base from U.S. Geological Survey Digital Line Graph, 1:2,000,000, 1987
Adapted physiography from Fenneman and Johnson (1946), 1:7,000,000, and Virginia Geologic Map, Dicken and others (2005), 1:500,000

Figure 1. Selected peak-flow study sites and physiographic provinces for application of peak-flow regional estimating equations.

REFERENCE 3

Table 3. Regional regression equations for estimating peak flows of streams in Virginia.

[DA, basin drainage area in square miles]

	Pseudo R-square[a]	Average standard error of prediction[a] (in percent)	Standard model error[a] (in percent)
Virginia basins in the Coastal Plain region			
Log10(0.2 peak) = 1.918 + 0.644 • Log10(DA)	0.91	48	44
Log10(0.1 peak) = 2.107 + 0.626 • Log10(DA)	0.90	51	47
Log10(0.04 peak) = 2.315 + 0.609 • Log10(DA)	0.88	56	51
Log10(0.02 peak) = 2.457 + 0.594 • Log10(DA)	0.86	60	55
Log10(0.01 peak) = 2.580 + 0.583 • Log10(DA)	0.84	65	58
Log10(0.005 peak) = 2.698 + 0.573 • Log10(DA)	0.82	71	64
Virginia basins in the Piedmont region, except those within the Mesozoic Basin region			
Log10(0.5 peak) = 2.197 + 0.593 • Log10(DA)	0.74	46	43
Log10(0.4292 peak) = 2.287 + 0.576 • Log10(DA)	0.74	45	42
Log10(0.2 peak) = 2.540 + 0.551 • Log10(DA)	0.93	34	32
Log10(0.1 peak) = 2.719 + 0.534 • Log10(DA)	0.93	33	31
Log10(0.04 peak) = 2.916 + 0.514 • Log10(DA)	0.92	34	32
Log10(0.02 peak) = 3.043 + 0.501 • Log10(DA)	0.91	36	34
Log10(0.01 peak) = 3.157 + 0.490 • Log10(DA)	0.90	38	36
Log10(0.005 peak) = 3.263 + 0.480 • Log10(DA)	0.89	41	38
Virginia basins in the Mesozoic Basin region			
Log10(0.5 peak) = 2.002 + 0.722 • Log10(DA)	0.85	44	41
Log10(0.4292 peak) = 2.090 + 0.707 • Log10(DA)	0.85	44	42
Log10(0.2 peak) = 2.416 + 0.660 • Log10(DA)	0.83	44	42
Log10(0.1 peak) = 2.656 + 0.624 • Log10(DA)	0.82	44	41
Log10(0.04 peak) = 2.923 + 0.586 • Log10(DA)	0.81	43	40
Log10(0.02 peak) = 3.097 + 0.561 • Log10(DA)	0.80	42	39
Log10(0.01 peak) = 3.265 + 0.537 • Log10(DA)	0.80	41	37
Log10(0.005 peak) = 3.401 + 0.521 • Log10(DA)	0.80	40	36
Virginia basins in the Blue Ridge region			
Log10(0.5 peak) = 2.127 + 0.709 • Log10(DA)	0.98	18	17
Log10(0.4292 peak) = 2.204 + 0.700 • Log10(DA)	0.98	19	18
Log10(0.2 peak) = 2.490 + 0.668 • Log10(DA)	0.97	22	20
Log10(0.1 peak) = 2.689 + 0.647 • Log10(DA)	0.95	26	24
Log10(0.04 peak) = 2.893 + 0.629 • Log10(DA)	0.92	31	29
Log10(0.02 peak) = 3.030 + 0.616 • Log10(DA)	0.91	34	32
Log10(0.01 peak) = 3.184 + 0.593 • Log10(DA)	0.86	33	30
Log10(0.005 peak) = 3.288 + 0.586 • Log10(DA)	0.83	37	33
Virginia basins in the Valley and Ridge region			
Log10(0.5 peak) = 2.053 + 0.733 • Log10(DA)	0.94	24	22
Log10(0.4292 peak) = 2.121 + 0.725 • Log10(DA)	0.94	24	23
Log10(0.2 peak) = 2.382 + 0.689 • Log10(DA)	0.92	25	24
Log10(0.1 peak) = 2.557 + 0.665 • Log10(DA)	0.90	28	27
Log10(0.04 peak) = 2.741 + 0.642 • Log10(DA)	0.86	33	31
Log10(0.02 peak) = 2.862 + 0.626 • Log10(DA)	0.83	37	35
Log10(0.01 peak) = 2.963 + 0.615 • Log10(DA)	0.80	41	39
Log10(0.005 peak) = 3.063 + 0.603 • Log10(DA)	0.76	46	43
Virginia basins in the Appalachian Plateau region			
Log10(0.5 peak) = 1.980 + 0.833 • Log10(DA)	0.94	0.25	0.23
Log10(0.4292 peak) = 2.048 + 0.824 • Log10(DA)	0.94	0.26	0.23
Log10(0.2 peak) = 2.289 + 0.798 • Log10(DA)	0.91	0.31	0.28
Log10(0.1 peak) = 2.450 + 0.781 • Log10(DA)	0.86	0.37	0.34
Log10(0.04 peak) = 2.631 + 0.759 • Log10(DA)	0.80	0.45	0.41
Log10(0.02 peak) = 2.740 + 0.750 • Log10(DA)	0.76	0.51	0.47

[a] Generalized least squares regression.

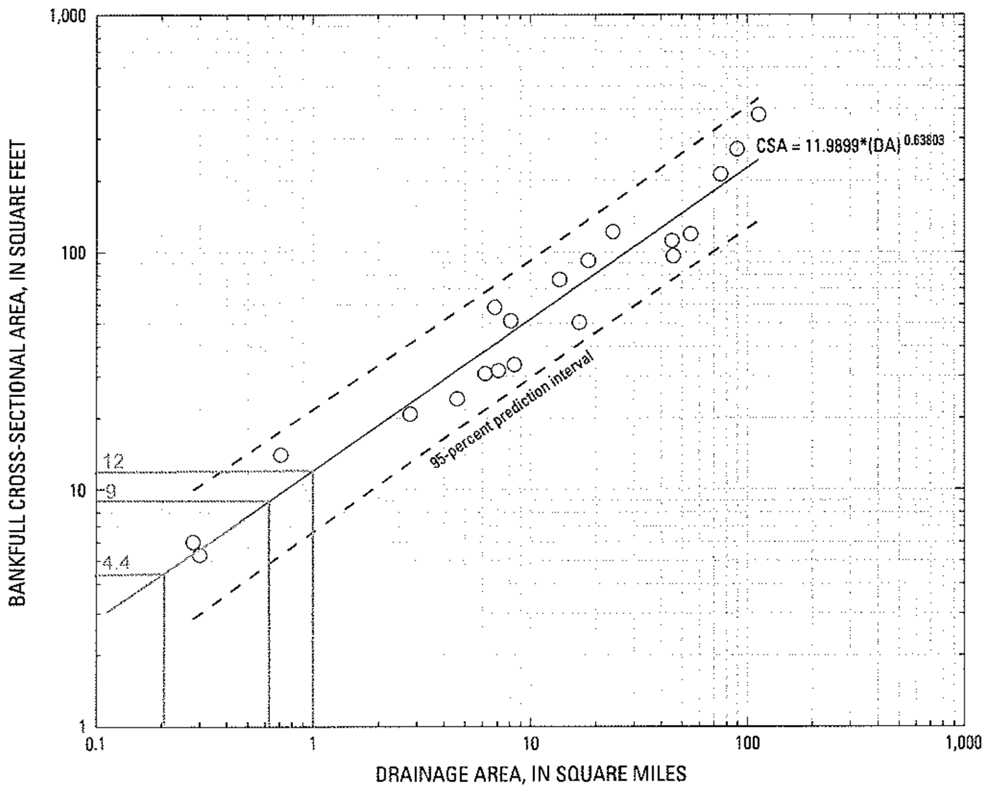


Figure 9. Regional curve relating bankfull cross-sectional area (CSA) to drainage area (DA) for streams in the non-urban, non-tidal Coastal Plain Physiographic Province of Virginia and Maryland.

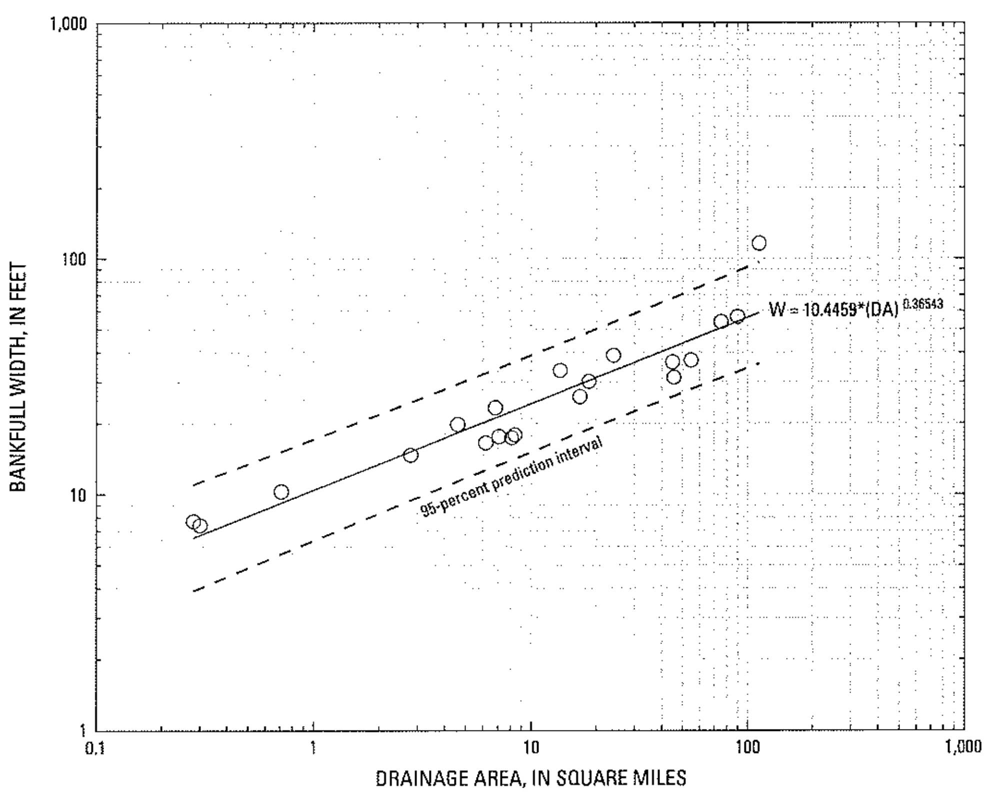


Figure 10. Regional curve relating bankfull width (W) to drainage area (DA) for streams in the non-urban, non-tidal Coastal Plain Physiographic Province of Virginia and Maryland.

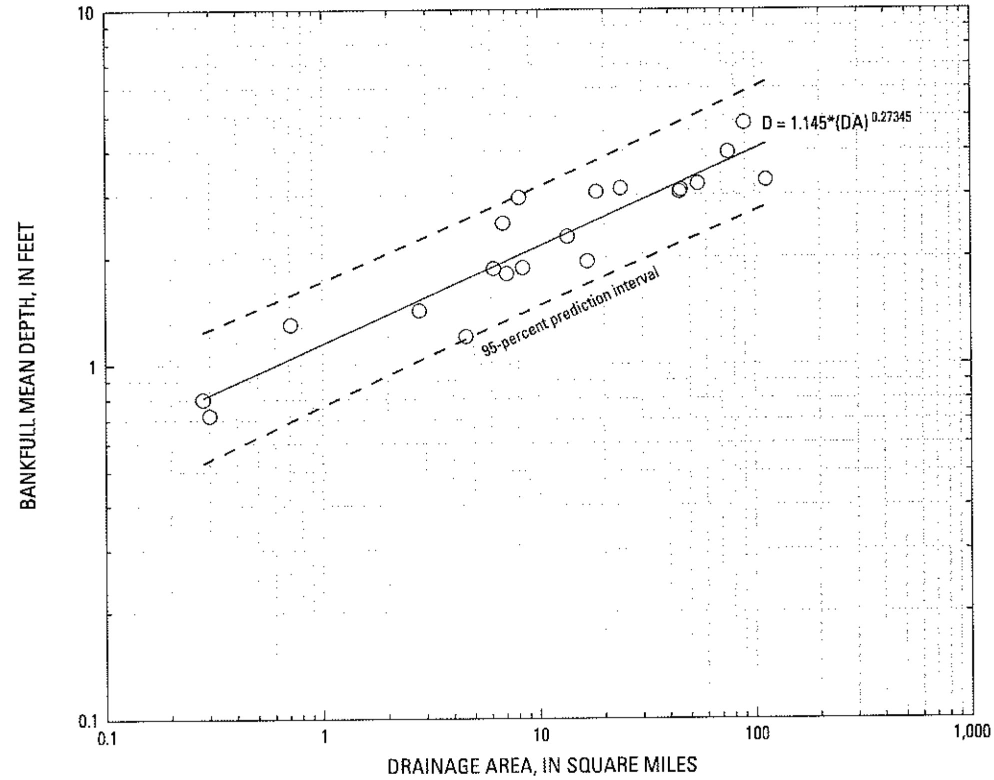


Figure 11. Regional curve relating bankfull mean depth (D) to drainage area (DA) for streams in the non-urban, non-tidal Coastal Plain Physiographic Province of Virginia and Maryland.

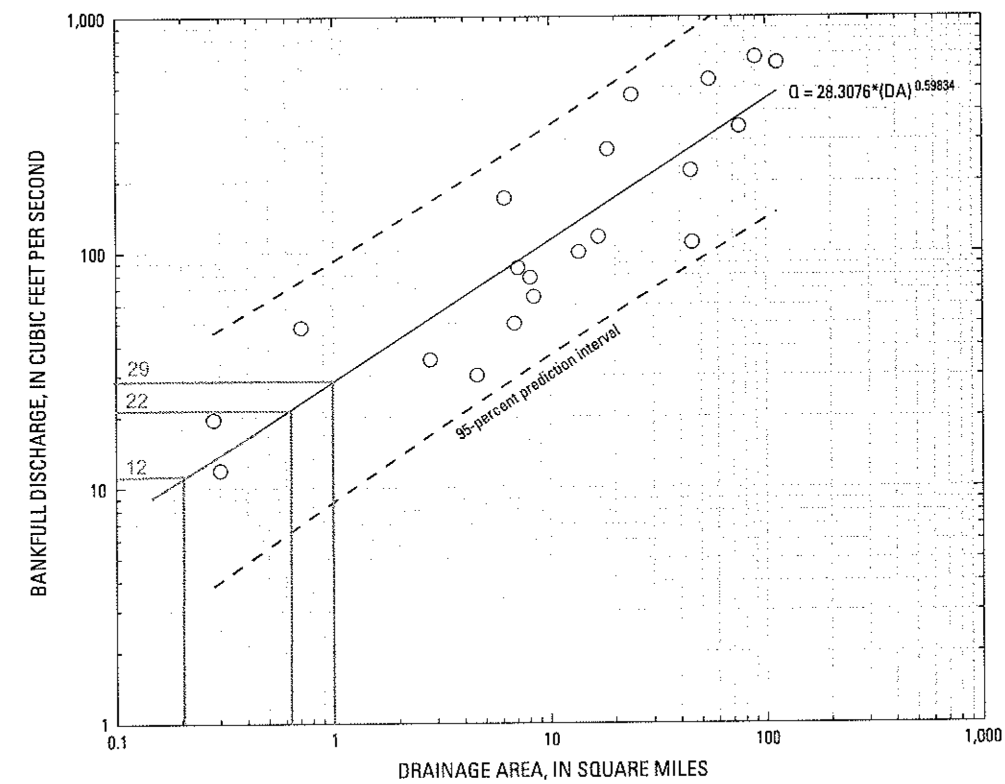


Figure 12. Regional curve relating estimated bankfull discharge (Q) to drainage area (DA) for streams in the non-urban, non-tidal Coastal Plain Physiographic Province of Virginia and Maryland.

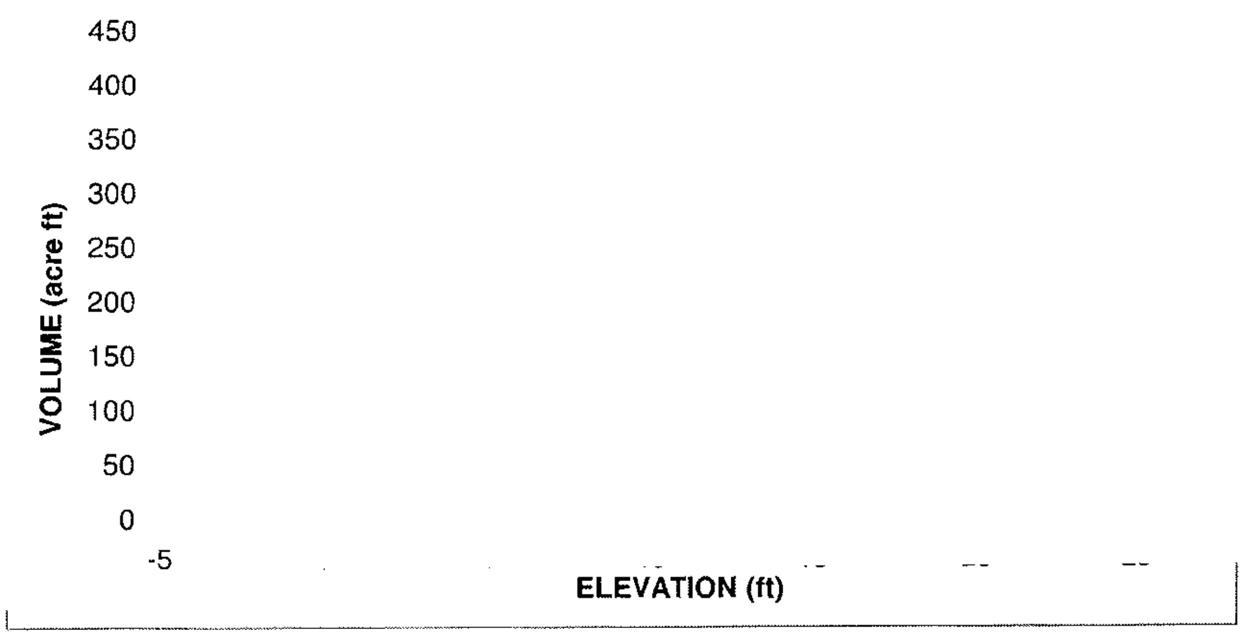
Project:
Subject:
Date
Filename G:\2010 Projects\Projects for Other Offices\10213086.00 (Dominion Possum Point Ash Pond E)\Data and Calcs\Hydrology and Hydraulics\[Stage Storage - Possum Point.xlsx]Stage Storage - Possum Point Rd

nty,

Notes

Elevation

-2
3
5
10
15
20



HEC-HMS: Reservoir Model Inputs
Basin Model "0.5PMF"

Reservoir: Pond E
Initial Elevation (ft): 38.3
Tailwater Condition: None -

Top of Dam Type	Overflow Coefficient	Top Elevation (ft)	Crest Length (ft)
Level Dam	2.6	42	3000

Spillway Type
Rating Curve Spillway : Principal Spillway

Reservoir: Possum Point Road
Initial Elevation (ft): 4.4
Tailwater Condition: Fixed Stage - 4.4 ft

Top of Dam Type	Overflow Coefficient
Non-Level Dam	2.6

Outlet Parameters:

Outlet Type	No. of Barrels	Culvert Shape	Culvert Length	Diameter (ft)
Culvert	1	Circular	64	6
Culvert	1	Circular	65	6

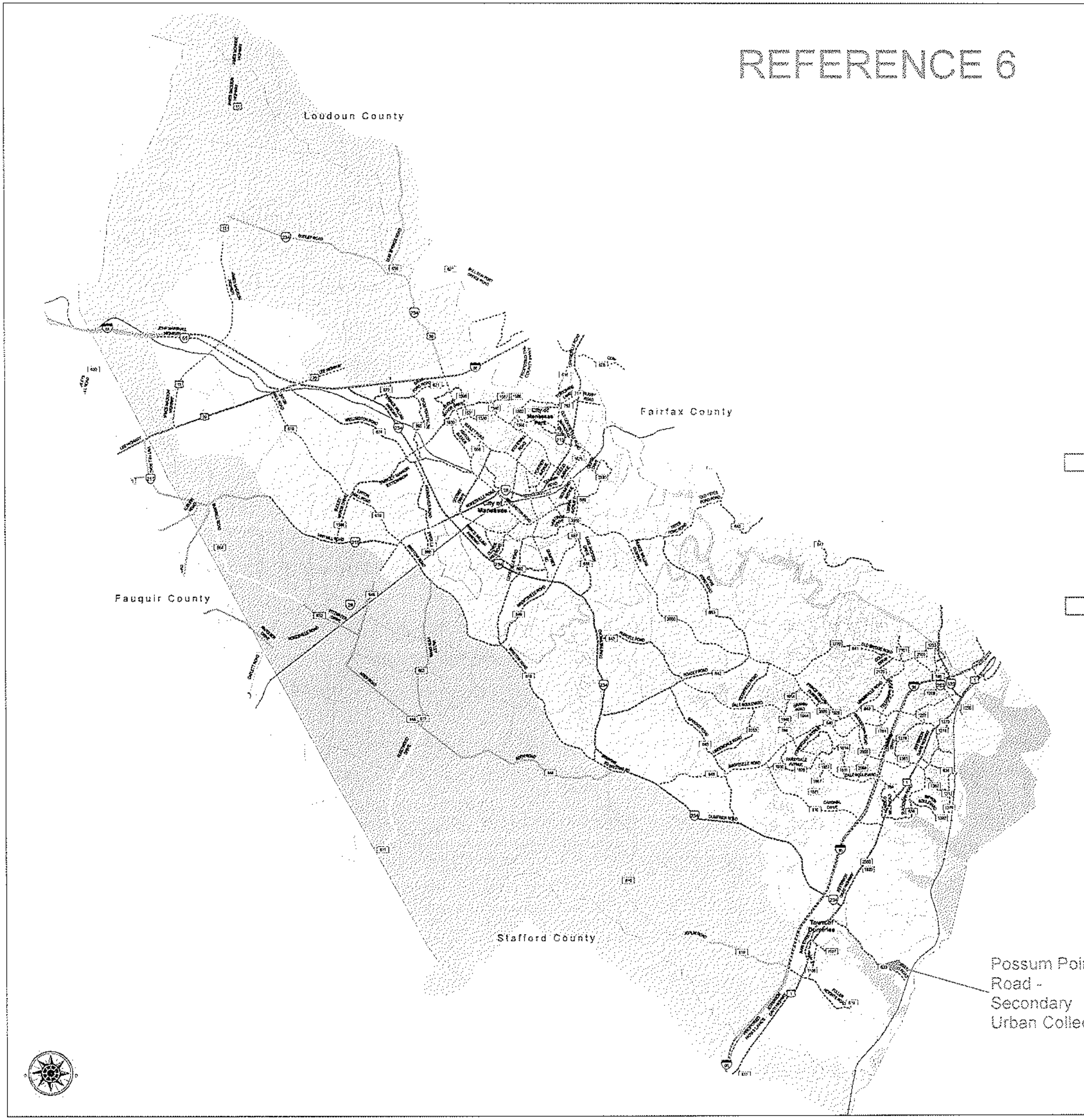
Outlet Parameters Continued:

Inlet Elevation (ft)	Entrance Loss Coefficient	Outlet Elevation (ft)	Exit Loss Coefficient	Manning's n
0.6	0.5	-0.84	1	0.013

Reservoir Inputs - 0.5 PMF
Ash Pond E and Downstream
Possum Point Ash Pond E (10213086)

REFERENCE 5

REFERENCE 6



Functional Classification Actions	FHWA Approval Date
1995 Functional Classification	May 10, 1993
2005 Functional Classification	July 3, 2007

The accuracy or completeness of the map is not guaranteed or warranted. The purpose of this map is to illustrate the Commonwealth of Virginia's official highway functional classification system. Information and mileages stated on this map are relevant to the highway functional classification system only.

Jurisdiction Boundaries, Urban Cluster Boundaries, Urbanized Area Boundaries, and MPO Study Area Boundaries based on Census 2000 data. However, some boundary data has been modified, or smoothed, for transportation planning purposes. Urban Cluster Boundaries are only shown when outside of Urbanized Area Boundaries.

Request for information on the functional classification of roads on this map should be addressed to: Virginia Department of Transportation, Transportation and Mobility Planning Division, State Transportation Planner, 1401 East Broad Street, Richmond VA 23219, 804-786-2985 (TTY users, call 711).

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Proposed | Existing

FUNCTIONAL CLASSIFICATIONS
- Urban Interstate
- Urban Freeway & Expressway
- Urban Other Principal Arterial
- Urban Minor Arterial
- Urban Collector
- Rural Interstate
- Rural Other Principal Arterial
- Rural Minor Arterial
- Rural Major Collector
- Rural Minor Collector
- Not Classified, Urban Local, Rural Local

HIGHWAY ROUTE SIGNS
- Interstate
- US Highway
- VA Primary
- VA Secondary

BOUNDARIES
- Jurisdiction Boundary
- Urban Cluster Boundary
- Urbanized Area Boundary
- MPO Study Area Boundary

OTHER
- Railroads
- Major Water Feature

VIRGINIA HIGHWAY FUNCTIONAL CLASSIFICATION

Prince William County

2005 Functional Classification

VDOT Virginia Department of Transportation

Prince William County 076

Table 6-1. Design Storm Selection Guidelines
(For Traveled Way Inundation)*

Roadway Classification	Exceedence Probability	Return Period
Rural Principal Arterial System	2%	50-yr
Rural Minor Arterial System	4% - 2%	25 yr - 50-yr
Rural Collector System, Major	4%	25-yr
Rural Collector System, Minor	10%	10-yr
Rural Local Road System	10%	10-yr
Urban Principal Arterial System	4% - 2%	25 yr - 50-yr
Urban Minor Arterial Street System	4%	25-yr
Urban Collector Street System	10%	10-yr
Urban Local Street System	10%	10-yr

Note: Federal law requires interstate highways to be provided with protection from the 2% flood. Facilities such as underpasses and depressed roadways, where no overflow relief is available, should also be designed for the 2% event.

* Rev 9/09

- Grade of the pipe is less than 0.5%
- Fills (not height of cover) greater than 20'

- Diameter or span 36" or greater
- Foundation is subject to settlement

The Drainage Designer will request that the Materials Division determine the amount of anticipated settlement along the pipeline. This request will accompany the request for culvert foundation data. The plan description for the structure will then note a camber equal to the amount of anticipated settlement.*

8.3.2 Hydraulic Criteria

These criteria relate to the hydraulic design of culverts based on flood flows, upstream and downstream water surface elevations, allowable velocities, and flow routing.

8.3.2.1 Flood Frequency

Culverts should be designed to accommodate the following minimum flood frequencies where the primary concern is the maintenance of traffic flow and the convenience of the highway user:

Roadway	*Flood Frequency (Annual Risk)*
Interstate	50-year (2%)
Primary & Arterial	25-year (4%)
Secondary	10-year (10%)

The above requirements are minimum, and deviation requires approval from VDOT. Culverts should be designed to pass floods greater than those noted above where warranted by potential damage to adjacent property, loss of human life, injury, or heavy financial loss.

Future development of contributing watersheds and floodplains that have been zoned or delineated should be considered in determining the design flood. For the Interstate System, development during a period 20 years in the future should be considered. Adopted regional plans and approved zoning will be considered in determining the design discharge on all systems.

In compliance with the National Flood Insurance Program (NFIP) it is necessary to consider the 100-year frequency flood at all locations where construction will encroach

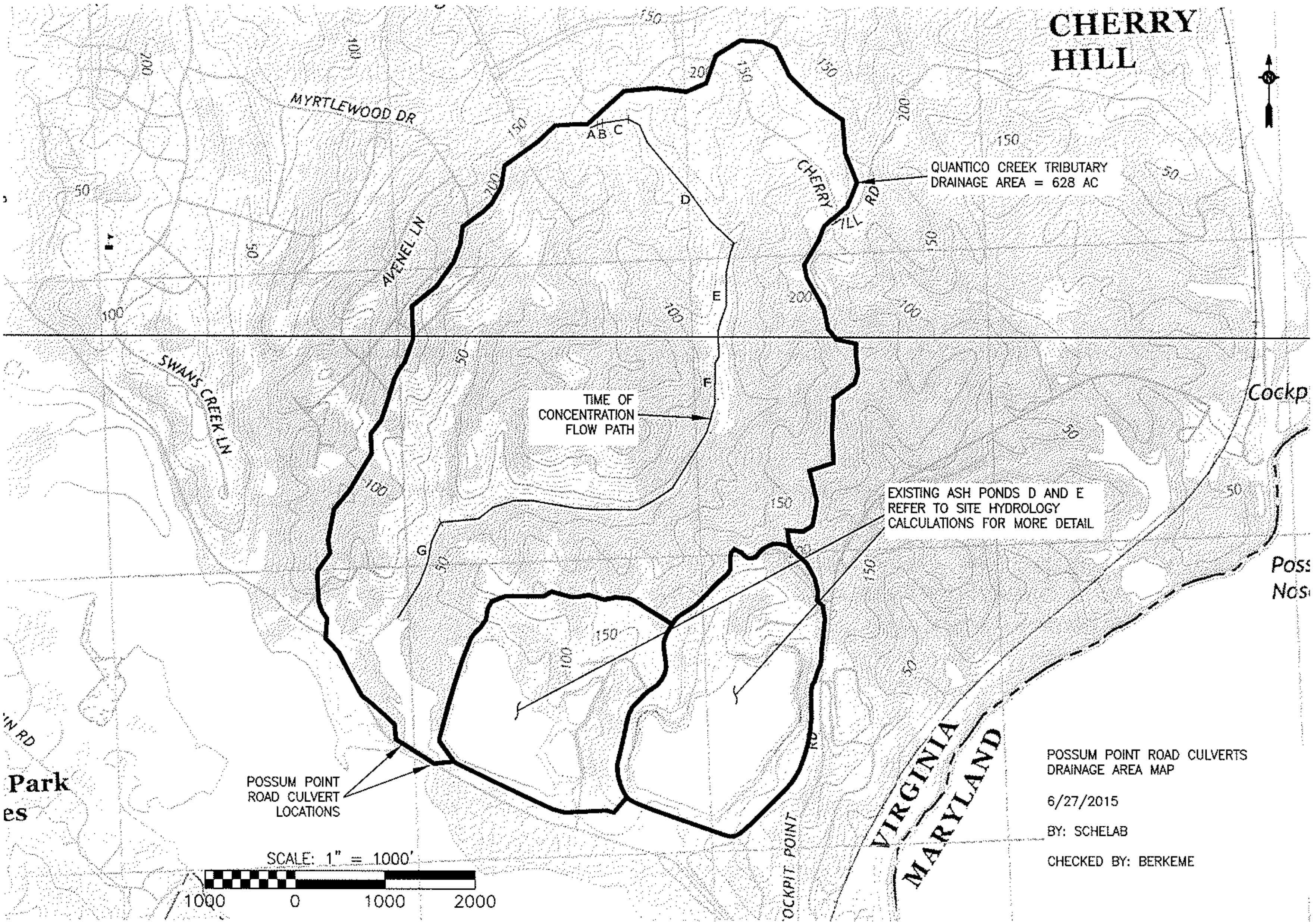
* Rev 7/14

SUBJECT POSSUM POINT CCR POND CLOSURES
EVALUATION OF POSSUM POINT ROAD CULVERT
BY SCHELAB DATE 8/23/2015 PROJ. NO. C150132.00
CHKD. BY BERKEME DATE 8/24/2015

gai consultants

ATTACHMENT 2

Hydrologic Calculations for Tributary to Quantico Creek


CHERRY HILL
MYRTLEWOOD DR
AVENEL LN
SWANS CREEK LN
CHERRY HILL RD
QUANTICO CREEK TRIBUTARY DRAINAGE AREA = 628 AC
TIME OF CONCENTRATION FLOW PATH
EXISTING ASH PONDS D AND E REFER TO SITE HYDROLOGY CALCULATIONS FOR MORE DETAIL
POSSUM POINT ROAD CULVERT LOCATIONS
SCALE: 1" = 1000'
1000 0 1000 2000
VIRGINIA
MARYLAND
POSSUM POINT ROAD CULVERTS DRAINAGE AREA MAP
6/27/2015
BY: SCHELAB
CHECKED BY: BERKEME

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Hydrologic Soil Group—Prince William County, Virginia
(Possum Point Road Culvert Drainage Area)

Map Scale: 1:14,300 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0, 200, 400, 800, 1200

Feet: 0, 500, 1000, 2000, 3000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Prince William County, Virginia
Survey Area Data: Version 12, Dec 13, 2013

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Data not available.

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

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21 of 36

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Prince William County, Virginia (VA153)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
16A	Delanco fine sandy loam, 0 to 4 percent slopes	C/D	46.1	7.3%
18C	Dumfries sandy loam, 7 to 15 percent slopes	A	10.5	1.7%
18D	Dumfries sandy loam, 15 to 25 percent slopes	A	6.5	1.0%
18E	Dumfries sandy loam, 25 to 50 percent slopes	A	167.2	26.6%
27A	Hatboro-Codorus complex, 0 to 2 percent slopes	B/D	6.8	1.1%
34D	Lunt loam, 15 to 25 percent slopes	B	2.7	0.4%
36D	Marr very fine sandy loam, 7 to 25 percent slopes	B	82.1	13.1%
36E	Marr very fine sandy loam, 25 to 50 percent slopes	B	212.2	33.7%
37A	Marumsco loam, 0 to 4 percent slopes	C/D	4.7	0.8%
42B	Neabsco-Quantico complex, 2 to 7 percent slopes	D	18.6	3.0%
47B	Quantico sandy loam, 2 to 7 percent slopes	B	37.6	6.0%
47C	Quantico sandy loam, 7 to 15 percent slopes	B	23.6	3.8%
W	Water		10.2	1.6%
Totals for Area of Interest			**628.9**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: *None Specified*

Tie-break Rule: Higher

Runoff Curve Number

Project: Possum Point Pond Closures - H&H Calculations C150132.00	By: SCHELAB	Date: 6/26/2015
Location: Drainage Area to Possum Point Road Culvert	Checked: BERKEME	Date: 7/2/2015

Check one: ■ Present ❑ Under Development ❑ Developed

Hydrologic Group	Cover Description	CN			Area	Product of CN x Area
		Table 2-2*	Figure 2-3	Figure 2-4	■ Acres ❑ miles^2 ❑ %	
A	Woods (good)	30			140.8	4,223
B	Woods (good)	55			279.1	15,351
C	Woods (good)	70			38.9	2,724
D	Woods (good)	77			22.1	1,702
A	Meadow	30			40.1	1,202
B	Meadow	58			79.5	4,610
C	Meadow	71			11.1	787
D	Meadow	78			6.3	491
Water	Water	98			10.2	1,000
			TOTALS		**628.0**	**32,089**

CN (weighted) = Total Product / Total Area

CN	**51**

*From USDA's TR-55 "Urban Hydrology for Small Watersheds"

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Possum Point Pond Closures C150132.00	By: SCHELAB	Date: 6/23/2015
Location: Possum Point Road Culverts	Checked: BERKEME	Date: 7/2/2015

Check one: ■ Present ❑ Under Development ❑ Developed

Sheet Flow

Segment ID	A		
Surface Description	WOODS		
Manning's Roughness Coefficient, n	0.4		(TR-55, Table 3-1)
Flow Length, L	100	ft	
Two-year 24-hour Rainfall, P_2	3.12	in	
Land Slope, s	0.07	ft/ft	
Travel Time, $T_t = (0.007*(n*L)^{0.8}) / (P_2^{0.5}*s^{0.4})$	**0.2196**	**hrs**	

Shallow Concentrated Flow

Segment ID	B	C	D		
Surface Description (Paved / Unpaved)	Unpaved	Unpaved	Unpaved		
Surface Description Coefficient, C	16.13	16.13	16.13		
Flow Length, L	57	292	1830		ft
Watercourse Slope, s	0.070	0.170	0.029		ft/ft
Average Velocity, $V = C*s^{0.5}$	4.27	6.65	2.75		ft/sec
Travel Time, $T_t = (L) / (3600*V)$	**0.004**	**0.012**	**0.185**		**hrs**

Channel Flow (Based on SIR 207-5162 Data)

Segment ID	E	F	G	
Cross Sectional Flow Area, A	4.4	9	12	ft^2
Bankfull Discharge, Q	12.00	22.00	29.00	cfs
Velocity, V	2.73	2.44	2.42	ft
Flow Length, L	1065	4518	1176	ft
Travel Time, $T_t = (L) / (3600*V)$	**0.1085**	**0.5134**	**0.1352**	**hrs**

Time of Concentration

Sheet Flow T_t	0.2196	hrs
Shallow Concentrated Flow T_t	0.2009	hrs
Channel Flow Tt	0.7571	hrs
Time of Concentration, T_c	**1.1776**	**hrs**
	71	**mins**

Z:\Energy\2015\C150132.00 - DOM - Possum Point PS CCB\Working Docs\ENGINEERING\H & H\VDOT Culvert Eval\PossumPointCulvert_Hydrology.xlsx

SUBJECT POSSUM POINT CCR POND CLOSURES
EVALUATION OF POSSUM POINT ROAD CULVERT
BY SCHELAB DATE 8/23/2015 PROJ. NO. C150132.00
CHKD. BY BERKEME DATE 8/24/2015

gai consultants

ATTACHMENT 3

HY-8 Calculations

HY-8 Culvert Analysis Report

Possum Point Road Culvert Evaluation

Normal Water Surface Elevation on Quantico Creek

By: SCHELAB, 6/26/2015

Checked by: BERKEME, 7/2/2015

Table 1 - Culvert Summary Table: Possum Point Road Culverts

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	5.00	0.000	4.400	0-NF	0.000	0.000	5.840	6.000	0.000	0.000
150.00	150.00	5.22	3.191	4.622	1-S1t	1.372	2.314	5.840	6.000	2.778	0.000
300.00	300.00	5.94	4.931	5.339	1-S1t	1.977	3.322	5.840	6.000	5.557	0.000
450.00	450.00	7.11	6.509	6.057	5-S2n	2.466	4.102	3.037	6.000	15.670	0.000
600.00	600.00	9.02	8.417	7.347	5-S2n	2.908	4.731	3.610	6.000	16.893	0.000
750.00	750.00	11.49	10.888	9.004	5-S2n	3.328	5.209	4.123	6.000	18.131	0.000
900.00	876.65	14.06	13.460	10.690	5-S2n	3.679	5.492	4.511	6.000	19.252	0.000
1000.00	882.06	14.18	13.579	10.768	5-S2n	3.694	5.502	4.527	6.000	19.303	0.000
1200.00	889.29	14.34	13.740	10.873	5-S2n	3.714	5.514	4.548	6.000	19.373	0.000
1350.00	893.66	14.44	13.838	10.937	5-S2n	3.726	5.521	4.560	6.000	19.416	0.000
1500.00	897.62	14.53	13.927	10.995	5-S2n	3.737	5.527	4.571	6.000	19.454	0.000

****

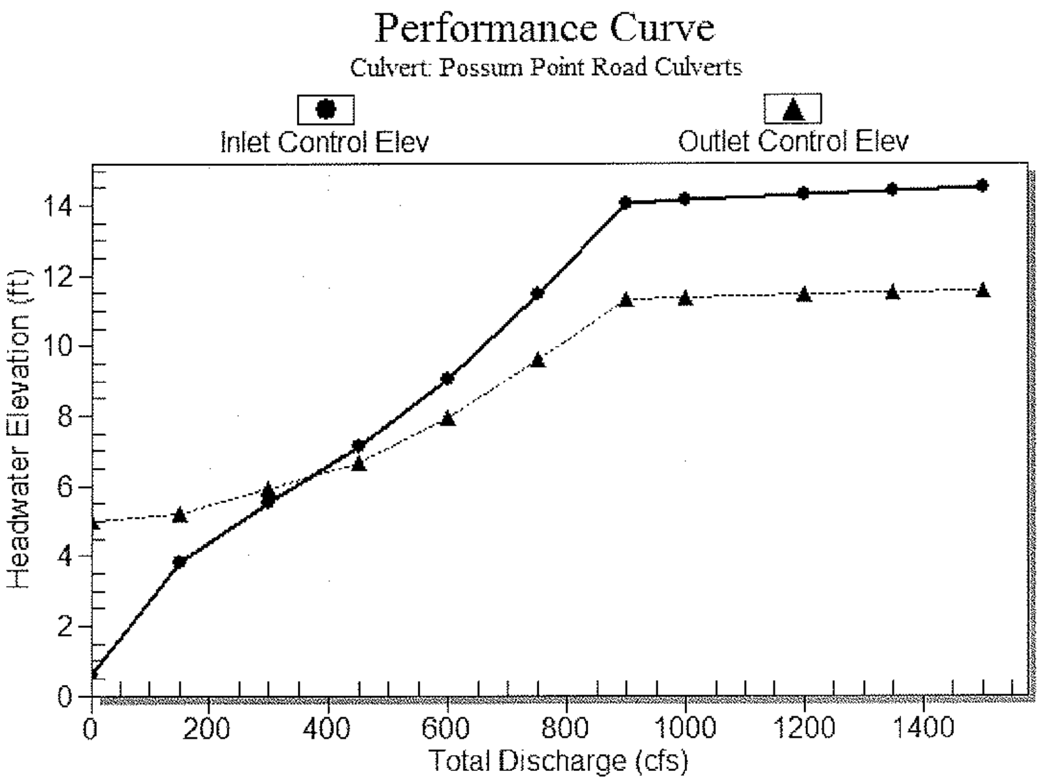
Straight Culvert

Inlet Elevation (invert): 0.60 ft, Outlet Elevation (invert): -0.84 ft

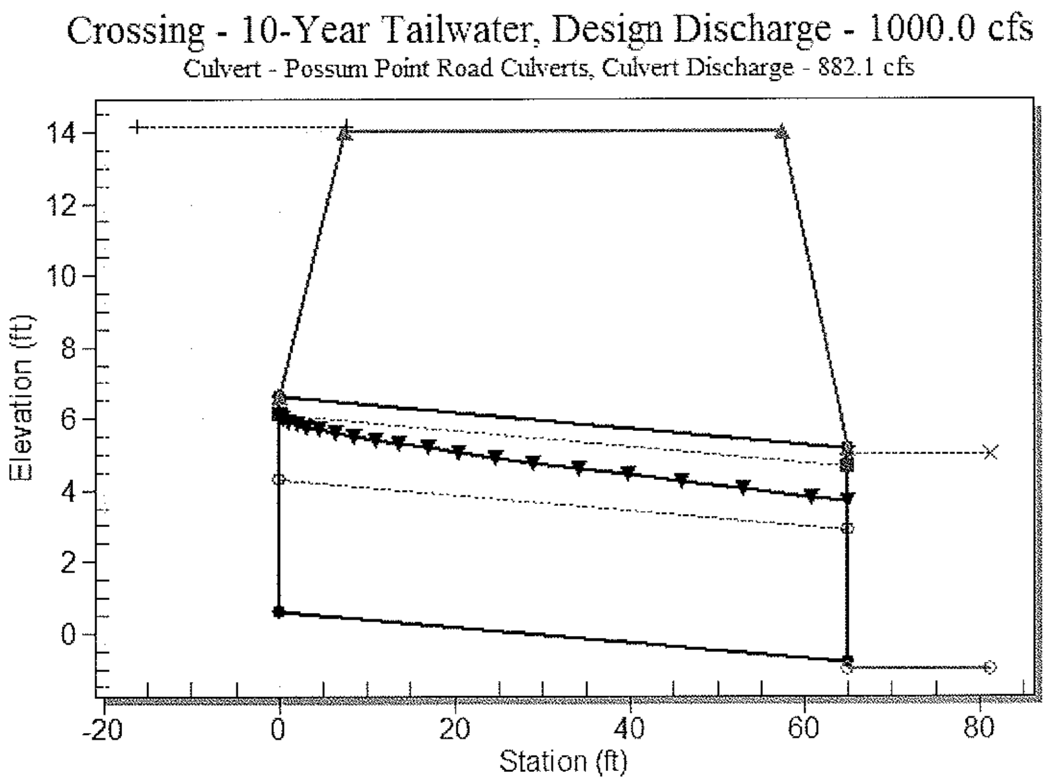
Culvert Length: 65.02 ft, Culvert Slope: 0.0222

****

Culvert Performance Curve Plot: Possum Point Road Culverts



Water Surface Profile Plot for Culvert: Possum Point Road Culverts



Site Data - Possum Point Road Culverts

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 0.60 ft

Outlet Station: 65.00 ft

Outlet Elevation: -0.84 ft

Number of Barrels: 2

Culvert Data Summary - Possum Point Road Culverts

Barrel Shape: Circular

Barrel Diameter: 6.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0130

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 2 - Downstream Channel Rating Curve (Crossing: 10-Year Tailwater)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
0.00	5.00	6.00
150.00	5.00	6.00
300.00	5.00	6.00
450.00	5.00	6.00
600.00	5.00	6.00
750.00	5.00	6.00
900.00	5.00	6.00
1000.00	5.00	6.00
1200.00	5.00	6.00
1350.00	5.00	6.00
1500.00	5.00	6.00

Tailwater Channel Data - 10-Year Tailwater

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 5.00 ft

Roadway Data for Crossing: 10-Year Tailwater

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 520.00 ft

Crest Elevation: 14.00 ft

Roadway Surface: Paved

Roadway Top Width: 50.00 ft

ATTACHMENT 4

HEC-HMS Routing

100-YEAR STORM

Summary Results for Reservoir "Trib to Quantico Creek"

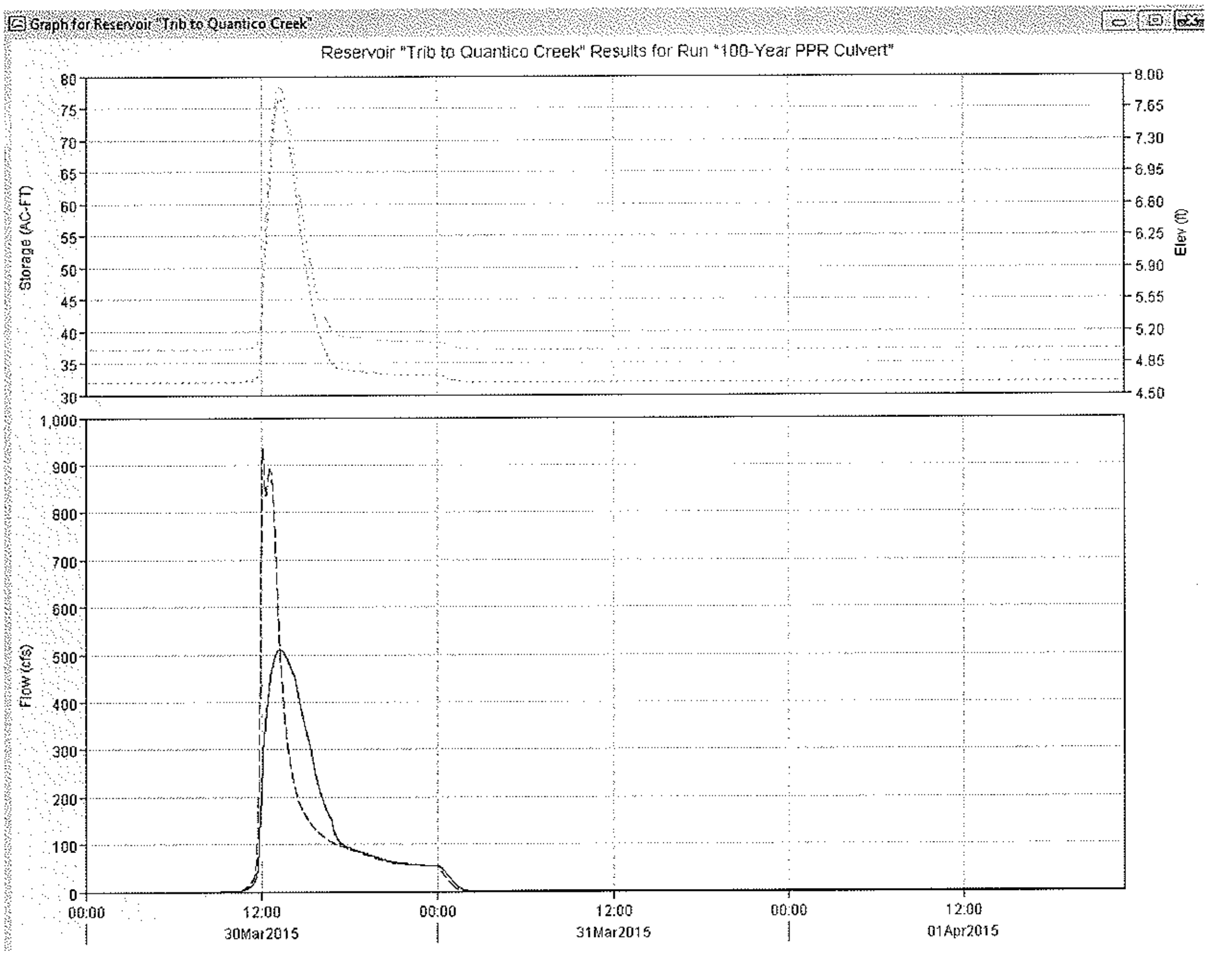
Project: Ponds D and E Simulation Run: 100-Year PPR Culvert
Reservoir: Trib to Quantico Creek

Start of Run:	30Mar2015, 00:00	Basin Model:	Possum Piont Road Culvert
End of Run:	01Apr2015, 23:00	Meteorologic Model:	100-yr Storm
Compute Time:	23Aug2015, 16:08:09	Control Specifications:	Control 1

Volume Units: ◯ IN ◉ AC-FT

Computed Results

Peak Inflow:	934.1 (CFS)	Date/Time of Peak Inflow:	30Mar2015, 12:06
Peak Discharge:	510.2 (CFS)	Date/Time of Peak Discharge:	30Mar2015, 13:14
Inflow Volume:	194.7 (AC-FT)	Peak Storage:	76.5 (AC-FT)
Discharge Volume:	194.7 (AC-FT)	Peak Elevation:	7.9 (FT)



10-Year Storm

Summary Results for Reservoir "Trib to Quantico Creek"

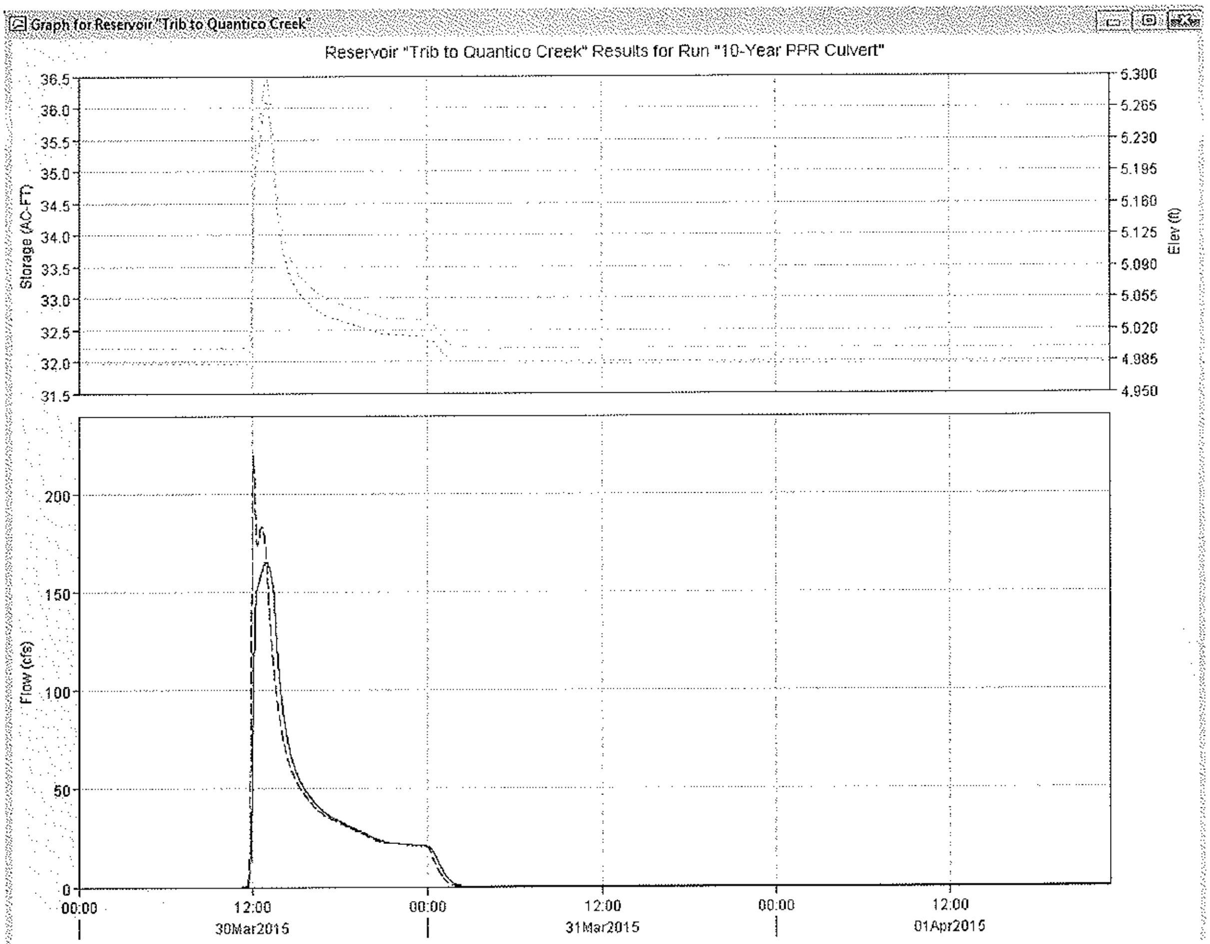
Project: Ponds D and E Simulation Run: 10-Year PPR Culvert
Reservoir: Trib to Quantico Creek

Start of Run:	30Mar2015, 00:00	Basin Model:	Possum Piont Road Culvert
End of Run:	01Apr2015, 23:00	Meteorologic Model:	10-yr Storm
Compute Time:	23Aug2015, 16:06:18	Control Specifications:	Control 1

Volume Units: IN AC-FT

Computed Results

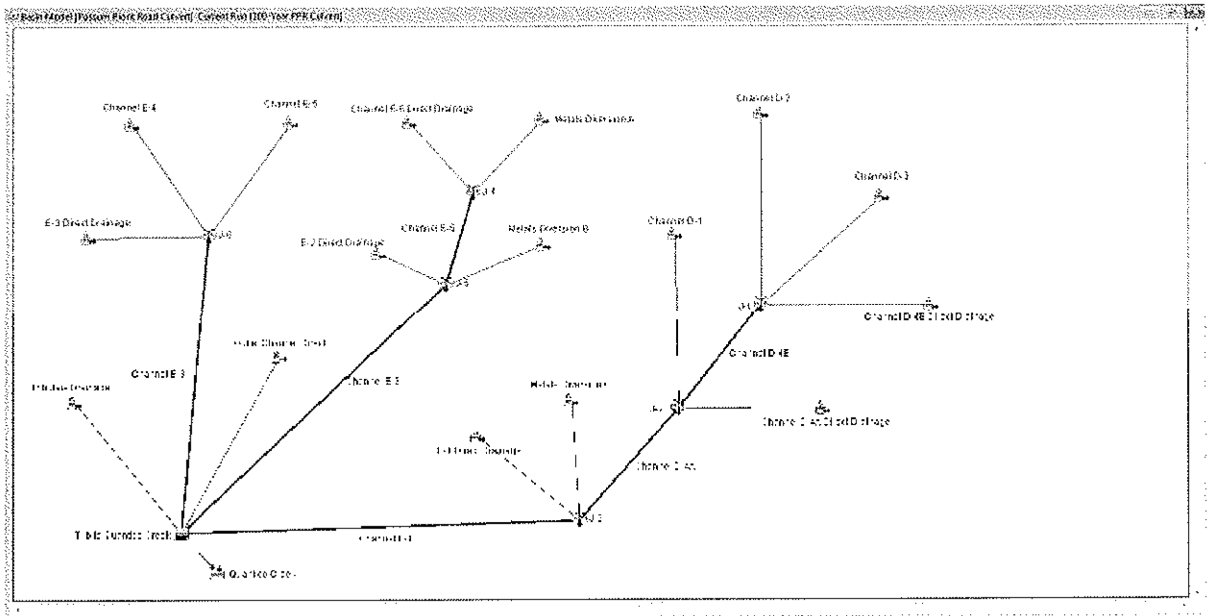
Peak Inflow:	219.3 (CFS)	Date/Time of Peak Inflow:	30Mar2015, 12:06
Peak Discharge:	165.6 (CFS)	Date/Time of Peak Discharge:	30Mar2015, 12:57
Inflow Volume:	54.3 (AC-FT)	Peak Storage:	36.1 (AC-FT)
Discharge Volume:	54.3 (AC-FT)	Peak Elevation:	5.3 (FT)

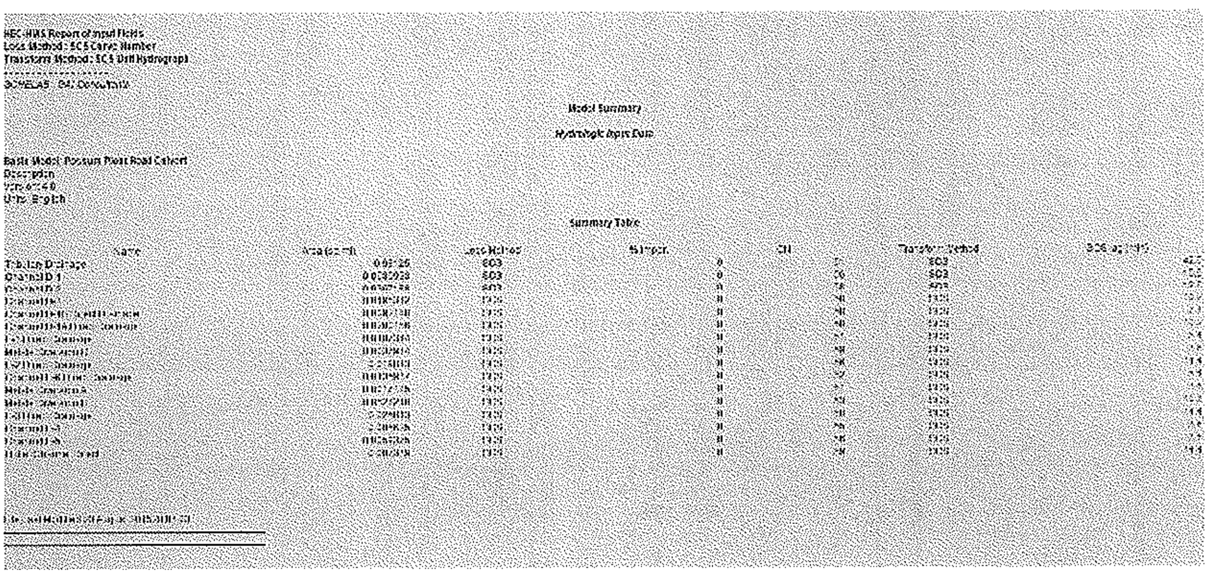


C150132.00 ATTACHMENT 4 8/23/2015

HEC-HMS Routing

BASIN SCHEMATIC AND INPUT SUMMARY





HEC-HMS Report of Input Fields
Loss Method : SCS Curve Number
Transform Method : SCS Unit Hydrograph

Model Summary

Hydrologic Input Data

Basin Model: Possum Point Road Culvert
Description
Version: 4.0
Units: English

Summary Table

Name	Area (sq mi)	Loss Method	% Impervious	CN	Transform Method	SCS Lag (min)
Tributary Drainage	[illegible]	SCS	0	[illegible]	SCS	[illegible]
Channel D 1	[illegible]	SCS	0	[illegible]	SCS	[illegible]
[illegible]	[illegible]	SCS	0	[illegible]	SCS	[illegible]
[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]

Note: This Model is the same as the Post development condition for the closure site with the additional fo the Tributary Drainage and PPR Culverts.

Elevation Area Curve for the Tributary to Quantico Creek

Paired Data | Table | Graph

Elevation (FT)	Area (AC)
-2.0000	0.00000
3.0000	10.50000
5.0000	13.70000
10.0000	19.30000
15.0000	24.80000
20.0000	32.70000

Elevation Discharge Curve for the PPR Culverts

Paired Data | Table | Graph

Elevation (FT)	Discharge (CFS)
-2.0000	0.00000
5.0000	0.00000
5.2200	150.00000
5.9400	300.00000
7.1100	450.00000
9.0200	600.00000
11.4900	750.00000
14.0600	876.65002
14.1800	882.06000
14.3400	889.28998
14.4400	893.65997
14.5300	897.62000

APPENDIX F
Water Quality Calculations

Purpose:

To determine the water quality requirements for the site based on the Virginia Runoff reduction method.

References:

1. Virginia Administrative Code 9VAC25-870 "Virginia Stormwater Management Program (VSMP) Regulation", July 1, 2014

2. Virginia Runoff Reduction Method (VRRM) ReDevelopment Worksheet –Version 2.8, June 2014

Assumptions:

1. Bodies of water and gravel access roads are considered impervious surfaces.

2. Disturbed areas that are not gravel access roads or proposed ponds will be considered managed turf as a worse case runoff scenario.

3. The proposed land disturbing activities are assumed to qualify as redevelopment because they are to be performed on prior developed land.

Procedure:

The VRRM worksheet created by the Virginia Department of Environmental Quality (VaDEQ) was used to compare the pre-redevelopment site conditions to the post-redevelopment site conditions to determine if the site complies with VSMP regulations for water quality. See the attached sheets.

The proposed project for Pond ABC involves 21.06 acres of disturbance to a site with 0.2 acres of impervious access roads. The limits of disturbance for Ponds D/E involve 85.99 acres for Pond D, 42.40 acres for Pond E, and 46.15 acres of combined potential borrow areas. Pond D/ E has 73.66 acres of existing impervious area made up of existing ponds and gravel access roads, this will be reduced to 19.93 acres for post-redevelopment.

Conclusions:

Based on the VRRM redevelopment worksheet the proposed site improvements will not create conditions that require the installation of additional water treatment or runoff reducing methods in order to comply with VSMP regulations for water quality.

Virginia Runoff Reduction Method ReDevelopment Worksheet - v2.8 - June 2014

Site Data Summary

Total Rainfall = 43 inches

Site Land Cover Summary

	A Soils	B Soils	C Soils	D Soils	Total	% of Total
Forest (acres)	0.00	0.00	0.00	0.00	0.00	*0.00*
Turf (acres)	0.00	20.86	0.00	0.00	20.86	*99.05*
Impervious (acres)	0.00	0.20	0.00	0.00	0.20	*0.95*
					21.06	*100.00*

Site Rv	0.21
Post Development Treatment Volume (ft^3)	15834
Post Development TP Load (lb/yr)	9.95
Post Development TN Load (lb/yr)	71.17
Total TP Load Reduction Required (lb/yr)	0.00

Total Runoff Volume Reduction (ft^3)	0
Total TP Load Reduction Achieved (lb/yr)	0
Total TN Load Reduction Achieved (lb/yr)	0.00
Adjusted Post Development TP Load (lb/yr)	9.95
Remaining Phosphorous Load Reduction (Lb/yr) Required	0.00

Drainage Area Summary

	D.A. A	D.A. B	D.A. C	D.A. D	D.A. E	Total
Forest (acres)	0.00	0.00	0.00	0.00	0.00	*0.00*
Turf (acres)	0.00	0.00	0.00	0.00	0.00	*0.00*
Impervious (acres)	0.00	0.00	0.00	0.00	0.00	*0.00*
						0.00

Drainage Area Compliance Summary

	D.A. A	D.A. B	D.A. C	D.A. D	D.A. E	Total
TP Load Red. (lb/yr)	0.00	0.00	0.00	0.00	0.00	*0.00*
TN Load Red. (lb/yr)	0.00	0.00	0.00	0.00	0.00	*0.00*

Channel and Flood Protection

	Weighted CN	1-year storm Adjusted CN	2-year storm Adjusted CN	10-year storm Adjusted CN
Target Rainfall Event (in)		0.00	0.00	0.00
D.A. A CN	0	100	100	100
D.A. B CN	0	100	100	100
D.A. C CN	0	100	100	100
D.A. D CN	0	100	100	100
D.A. E CN	0	100	100	100

Virginia Runoff Reduction Method ReDevelopment Worksheet - v2.8 - June 2014

Site Data Summary

Total Rainfall = 43 inches

Site Land Cover Summary

	A Soils	B Soils	C Soils	D Soils	Total	% of Total
Forest (acres)	0.00	0.00	0.00	0.00	0.00	*0.00*
Turf (acres)	0.00	154.81	0.00	0.00	154.81	*88.59*
Impervious (acres)	0.00	19.93	0.00	0.00	19.93	*11.41*
					174.74	*100.00*

Site Rv	0.29
Post Development Treatment Volume (ft^3)	181121
Post Development TP Load (lb/yr)	113.80
Post Development TN Load (lb/yr)	814.09
Total TP Load Reduction Required (lb/yr)	0.00

Total Runoff Volume Reduction (ft^3)	0
Total TP Load Reduction Achieved (lb/yr)	0
Total TN Load Reduction Achieved (lb/yr)	0.00
Adjusted Post Development TP Load (lb/yr)	113.80
Remaining Phosphorous Load Reduction (Lb/yr) Required	0.00

Drainage Area Summary

	D.A. A	D.A. B	D.A. C	D.A. D	D.A. E	Total
Forest (acres)	0.00	0.00	0.00	0.00	0.00	*0.00*
Turf (acres)	0.00	0.00	0.00	0.00	0.00	*0.00*
Impervious (acres)	0.00	0.00	0.00	0.00	0.00	*0.00*
						0.00

Drainage Area Compliance Summary

	D.A. A	D.A. B	D.A. C	D.A. D	D.A. E	Total
TP Load Red. (lb/yr)	0.00	0.00	0.00	0.00	0.00	*0.00*
TN Load Red. (lb/yr)	0.00	0.00	0.00	0.00	0.00	*0.00*

Channel and Flood Protection

	Weighted CN	1-year storm Adjusted CN	2-year storm Adjusted CN	10-year storm Adjusted CN
Target Rainfall Event (in)		0.00	0.00	0.00
D.A. A CN	0	100	100	100
D.A. B CN	0	100	100	100
D.A. C CN	0	100	100	100
D.A. D CN	0	100	100	100
D.A. E CN	0	100	100	100

APPENDIX C
Construction Quality Assurance Plan

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Construction Quality Assurance Plan

Issued for Permit

Virginia Electric and Power Company
Possum Point Power Station
Coal Combustion Residual Surface Impoundment Closures
Dumfries, Virginia

GAI Project Number: C150132.00
November 2015

Dominion

Prepared by: GAI Consultants, Inc.
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Prepared for: Dominion Resources Services, Inc.
5000 Dominion Boulevard
Glen Allen, Virginia 23060-3308

Construction Quality Assurance Plan

Issued for Permit

Virginia Electric and Power Company
Possum Point Power Station
Coal Combustion Residual Surface Impoundment Closures
Dumfries, Virginia

GAI Project Number: C150132.00
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11/18/2015

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1.0 Introduction

This Construction Quality Assurance (CQA) Plan presents the guidelines necessary to provide certification that the Possum Point Power Station Coal Combustion Residual (CCR) Surface Impoundment Closures Project (Project) is constructed in accordance with its approved permit. It addresses inspection and verification activities and procedures necessary to determine and document the quality of key components of the constructed facility. These components include prepared subgrade preparation, geosynthetic cap system construction, drain pipe/trench construction, dam modifications, and final cover system construction.

The closure of the CCRs Surface Impoundment from site preparation through placement of the final cover system will be performed by qualified earthwork contractors.

2.0 Quality Control Responsibilities

At a minimum, the personnel involved in the construction include the Owner/Operator, Project Construction Manager, Quality Control (QC) Team, Owner's Engineer, Contractor, and other Installers. The responsibilities and authority of these personnel are defined in the following sections.
A pre-construction conference will be held prior to construction projects to discuss the roles and responsibilities of the parties involved.

2.1 Owner/Operator

The Owner is Virginia Power and Electric Company. The Owner will approve design revisions and administer related permit modifications. The Owner will designate one representative to serve as the Project Construction Manager.

2.2 Project Construction Manager

The Project Construction Manager (PCM) will be a Dominion employee or contractor designated to be the Owner's Representative for pond closures. The PCM will be responsible for management and administration of site construction and QC activities. The PCM's responsibilities include coordinating and managing QC Team activities, coordinating with the Owner's Professional Engineer, and coordinating activities with permitting agencies. The PCM will also:

- Coordinate activities with other contractors and consultants involved with the closure construction of the ponds;
- Approve design changes and submittals, through the Owner's Professional Engineer and QC Team; and
- Approve Change Orders and payment requests.

2.3 QC Team

The QC Team will be a representative of the Owner's Engineer and will include personnel qualified in construction quality assurance/QC and testing procedures pertinent and necessary to pond closure construction. QC Team personnel activities will be coordinated by the PCM or Owner's Engineer. QC Team personnel include any professional or technician necessary to provide Dominion with technical oversight or review of the construction of the facility. QC Team personnel will be familiar with CCR properties and characteristics, as well as functional intent of the design. The QC Team may also be called the CQA Consultant or CQA Personnel in the Technical Specifications.

2.4 Owner's Professional Engineer

The Owner's Professional Engineer (PE) shall be a Professional Engineer licensed in the State of Virginia (VA), who is responsible for certifying the construction of the Project meets the intent of the Construction Documents and other applicable regulatory requirements. The Owner's PE shall:

- Personally conduct random site visits to check on his representative (QC Team), the Contractor, and other elements of construction;
- Personally conduct a final site visit on the completed facilities for certification;
- Approve modifications to QC testing methods as designated herein or as outlined in Project requirements; and
- Be responsible for collection of documentation, review, and approval of submittals, review QC data for conformance with Project requirements, and generation of QC-related reports.

2.5 General Contractor

The General Contractor shall employ a full time QC Manager to:

- Prepare submittals;
- Coordinate with Owner's QC Team to ensure all required testing is being performed in a timely manner;
- Coordinate with Geosynthetics Installer to ensure material QC testing is being performed;
- Coordinate with Surveying Subcontractor to ensure adequate survey data is collected to allow for completion of as-built drawings; and
- Prepare red-line drawings for any changes to contract drawings.

2.6 Geosynthetics Installer

The Contractor's Geosynthetics Installer shall employ a full time QC Representative to ensure the Project geosynthetics (i.e., 40 mil LLDPE geomembrane, Geocomposite Drainage Net [GDN] and geotextiles) are installed and tested in accordance with the specifications. The Geosynthetics QC Representative shall document the geosynthetics installation and testing performed by the Geosynthetics Installer and coordinate with the General Contractor's QC Manager, and the Owner's QC team for conformance testing requirements.

2.7 Surveyor

The Contractor shall hire a surveyor to establish the lines and grades for construction, prepare the record drawings, and verify construction. All surveying shall be performed under the direct supervision of a Professional Licensed Surveyor. All survey results shall be certified by a VA registered professional land surveyor.

3.0 Soil Liner and Underdrain

3.1 Low Permeability Soil Liner

A portion of the existing Low Permeability Soil Liner under Surface Impoundment D may require removal during ash regrading activities. The liner will be re-established with a new 12-inch-thick liner of low permeability clay. Density testing and geotechnical sampling will be performed. Shelby Tube Sampling will be performed to confirm permeability requirements. All ongoing activities will be monitored daily by the QC Team.

3.1.1 Material

The material used to repair and replace the low permeability soil liner shall be free of unsuitable material, contaminated material, CCRs, cobbles, and boulders, and shall have a minimum permeability of 1×10^{-7} centimeters/second. In-place and source material testing requirements are summarized in Tables 12 and 13 attached to this report.

3.1.2 Construction

Low permeability soil liner placement and compaction control shall conform to the following requirements:

- The 12-inch low permeability soil layer shall be placed in two or more lifts.
- Compaction control testing shall be conducted on the 12-inch soil layer at a minimum frequency of three in-place density tests per acre per lift of soil layer, with at least three tests performed each day that cover is placed.

3.1.3 Test Pad

A minimum 50-foot by 50-foot test pad shall be constructed for every source of low permeability soil or soil type to demonstrate the ability of the soil to be used as a low permeability soil liner material. The test pad shall establish the range of compaction, moisture content, Unified Soil Classification System (USCS) classification, and grain size requirements that can be expected to achieve the low permeability liner requirements. The test pads shall be correlated with grain size analysis, liquid and plastic limits, moisture content, relative compaction, remolded permeability, and undisturbed Shelby Tube sample permeability.

Test pads may also be constructed following Geosynthetic Research Institute (GRI) GS11 to assess the potential for geomembrane puncture and to evaluate the need for a cushion geotextile.

3.2 Underdrain

Furnish and install underdrain geotextile, drainage aggregate and perforated high density polyethylene (HDPE) pipe in underdrains beneath the geosynthetic cap system as required to discharge CCR drainage during and after construction. Subsurface dewatering water, which is collected by any underdrain system, shall be pumped to the water treatment system to be installed in Surface Impoundment E. After the geosynthetic cap system is installed, the underdrains may continue to operate as a passive dewatering system. Once the underdrains have dried up due to sufficient dewatering of the CCR in the surface impoundment, the underdrains should be capped in place.

3.2.1 Geotextile Material

The hybrid monolithic woven-nonwoven needle-punched underdrain geotextile meeting the requirements of Table 10. Qualified materials shall be the top (hybrid) geotextile from CoalDrain 300 mil Geocomposite, as manufactured by GSE or equal as approved by the Owner's Representative.

- Geotextile Delivery, Handling, and Storage: Shall comply with Section 5.1.3;
- Geotextile Conformance Sampling and Testing: Table 10; and
- Geotextile Handling and Placement: Underdrain geotextile shall be placed in pond ash, **with the nonwoven side of the hybrid geotextile placed against the ash**. Underdrain geotextile shall be installed at locations necessary for construction dewatering and approved by the Owner's Representative. Continuously overlap underdrain geotextile panels a minimum of 18 inches across

the top of the trench and a minimum of three feet for end-to-end panels. All placement of underdrain geotextile and associated aggregate and piping shall be observed by the CQA Consultant. Underdrain geotextile installation shall be approved by the CQA Consultant prior to installation of the associated underdrain aggregate and piping.

3.2.2 Underdrain Pipe

- Underdrain pipe shall comply with Section 6.2.

3.2.3 Underdrain Aggregate

- Underdrain aggregate shall comply with Section 6.3.

4.0 Geosynthetic Clay Liner

Geosynthetic Clay Liner (GCL) may be installed over the existing low permeability bottom liner on the exposed side slopes of the existing pond. Surfaces that are to receive GCL shall be prepared in accordance with the contract drawings and specifications. The GCL Installer shall install GCL only on surfaces that have been approved in writing.

4.1 Material

Prior to, or coincident with, the shipment of the GCL to the Project site, the Owner's Representative shall review and approve submittals from the GCL Manufacturer, which shall include:

- GCL Manufacturer's GCL specification sheet(s); and
- GCL Manufacturer's Quality Control (MQC) Certificates.

4.2 Delivery, Handling, and Storage

All geotextile delivery, handling, and unloading shall be performed in the presence of the Owner's Representative. During unloading, the Contractor and Owner's Representative shall conduct an inspection of all delivered geotextile for defects and damage caused by inadequate or improper packaging, shipping, unloading, or handling. GCL having defects or damage shall be examined by the Owner's Representative to determine its acceptability.

Wrappings protecting GCL rolls shall be removed less than one hour prior to unrolling the GCL. The GCL shall not be exposed to sunlight for more than 15 days, unless otherwise specified or guaranteed by the GCL Manufacturer.

4.3 Conformance Sampling and Testing

Conformance sampling and testing of the GCL shall be performed by the Owner's Representative in accordance with the minimum sampling frequencies outlined in Table 4 of this CQA Plan. Conformance testing will be completed according to the following procedure:

- Cut a sample per manufacturer's recommendation. Do not include the first 3 feet of the roll. Mark the samples with an arrow indicating the machine direction of the geotextile.
- Label the sample and include all pertinent project and geotextile product information.
- Complete chain-of-custody and testing request forms and forward conformance samples to the Geosynthetics CQA Laboratory.

The Owner's Representative shall review results from all conformance testing to verify compliance with requirements. If all requirements are met, the Owner's Representative shall issue written acceptance of the GCL for deployment. If the requirements are not met, the Owner's Representative shall notify the Contractor and either resample/retest the failed roll/panel or mark the failed roll/panel as rejected. If the failed roll/panel is rejected, the Owner's Representative shall obtain conformance samples from the closest numerical roll/panel on each side of the failed roll/panel number. The two additional GCL samples must conform to Table 4 (included in this CQA Plan) for the applicable GCL. If either sample fails, the two numerically closest untested rolls on both sides of the failed sample will be tested by the Geosynthetics CQA Laboratory. These 10 samples must conform to the specifications. If any of these samples fail, every roll of GCL on-site and every subsequently delivered roll that is from the same supplier must be tested by the Geosynthetics CQA Laboratory for conformance.

5.0 Geosynthetic Cap System Construction

A multi-component geosynthetic cap system will be installed directly over the prepared subgrade. The geosynthetic cap system will consist of the following components from top to bottom:

- Drain GDN Layer with non-woven geotextile heat-bonded to both sides;
- Textured 40 mil Linear Low Density Polyethylene (LLDPE) Geomembrane; and
- Six ounces per square yard non-woven geotextile (Cushion Geotextile).

5.1 Cushion Geotextile

5.1.1 Cushion Geotextile

The cushion geotextile prevents damage to the LLDPE geomembrane from the prepared subgrade soil materials. The cushion geotextile will be 12 ounces per square yard (oz./sq.yd.) nonwoven, needle-punched geotextile installation, made up of polypropylene filaments. All geotextile installation activities will be monitored on a daily basis by the Owner's Representative and QC Team. The Owner's PE shall personally conduct random inspections to check on his representative, the contractor, and other elements of construction.

5.1.2 Material

Prior to, or coincident with, the shipment of the geotextile to the project site, the Owner's Representative shall review and approve submittals from the Geotextile Manufacturer, which shall include:

- Geotextile Manufacturer's geotextile specification sheet(s); and
- Geotextile Manufacturer's MQC Certificates.

5.1.3 Delivery, Handling, and Storage

All geotextile delivery, handling, and unloading shall be performed in the presence of the Owner's Representative. During unloading, the Contractor and Owner's Representative shall conduct an inspection of all delivered geotextile for defects and damage caused by inadequate or improper packaging, shipping, unloading, or handling. Geotextile having defects or damage shall be examined by the Owner's Representative to determine its acceptability.

Wrappings protecting geotextile rolls shall be removed less than one hour prior to unrolling the geotextile. The geotextile shall not be exposed to sunlight for more than 15 days, unless otherwise specified or guaranteed by the Geotextile Manufacturer.

5.1.4 Conformance Sampling and Testing

Conformance sampling and testing of the geotextile shall be performed by the Owner's Representative in accordance with the minimum sampling frequencies outlined in Tables 5a and 5b of this CQA Plan. Conformance testing will be completed according to the following procedure:

- Cut a sample from the geotextile that is 3 feet long by the full roll width. Do not include the first 3 feet of the roll. Mark the samples with an arrow indicating the machine direction of the geotextile.
- Label the sample and include all pertinent project and geotextile product information.
- Complete chain-of-custody and testing request forms and forward conformance samples to the Geosynthetics CQA Laboratory.

The Owner's Representative shall review results from all conformance testing to verify compliance with requirements. If all requirements are met, the Owner's Representative shall issue written acceptance of the geotextile for deployment. If the requirements are not met, the Owner's Representative shall notify the Contractor and either resample/retest the failed roll/panel or mark the failed roll/panel as rejected. If the failed roll/panel is rejected, the Owner's Representative shall obtain conformance samples from the closest numerical roll/panel on each side of the failed roll/panel number. The two additional geotextile samples must conform to Table 5a (included in this CQA Plan) for the applicable geotextile. If either sample fails, the five numerically closest untested rolls on both sides of the failed sample will be tested by the Geosynthetics CQA Laboratory. These 10 samples must conform to the Specifications. If any of these samples fail, every roll of geotextile on-site and every subsequently delivered roll that is from the same supplier must be tested by the Geosynthetics CQA Laboratory for conformance.

5.1.5 Handling and Placement

All geotextile deployment and seaming operations shall be performed in the presence of the Owner's Representative and QC Team. During geotextile deployment, the Owner's Representative and the QC Team should verify and/or document the following:

- On slopes, the geotextile is to be securely anchored and rolled down the slope in such a manner as to continually keep the geotextile in tension.
- In the presence of wind, all geotextiles are ballasted with sandbags or equivalent. Sandbags shall be installed during placement and shall remain until replaced with soil cover.
- Geotextile is kept continually under slight tension to minimize the presence of wrinkles in the geotextile.
- Geotextiles are cut with an approved geotextile cutter only. Special care is taken to protect the underlying geomembrane from damage which could be caused by the cutting of geotextile.
- The Installer takes any necessary precautions to prevent damage to the underlying layers during placement of the geotextile.
- During placement of geotextiles, care is taken to prevent the entrapment of stones, excessive dust, or moisture that could damage the underlying geomembrane or hamper subsequent seaming.
- All cushion geotextiles are continuously heat bonded using a method acceptable to the Owner's Representative or sewn together with two rows of Type 401 stitching (field stitch).

- Cushion geotextiles are overlapped at a minimum of 6 inches prior to heat bonding or sewing.
- Sewing is done using thread made from the same type of polymer as the geotextiles being sewn together.

5.1.6 Repair

During geotextile installation, the Owner's Representative and QC Team shall visually inspect all panels and seams for holes or tears and shall mark any such areas for repair. The Owner's Representative shall verify that the repairs are made in accordance with acceptable geotextile repair methods identified in the Technical Specifications.

5.1.7 Final Inspection and Covering

The Owner's Representative shall complete a visual inspection of all geotextile panels, seams, and repairs prior to accepting the geotextile installation. The Owner's Professional Engineer shall personally conduct a final inspection on the completed facilities for the certification. The Installer shall place all material located on top of the geotextile in such a manner to ensure that there is no damage to the geotextile and geosynthetics, that there is minimal slippage of the geotextile on underlying layers, and that there is no excess tensile stresses in the geotextile.

5.2 Geomembrane

The geomembrane serves as the hydraulic barrier in the pond cap system. The pond geomembrane will be comprised of textured LLDPE and have a nominal thickness of 40 mil. All geomembrane installation activities will be monitored on a daily basis by the Owner's Representative and QC Team. The Owner's Professional Engineer shall personally conduct random inspections to check on his representative, the contractor, and other elements of construction.

5.2.1 Material

Prior to, or coincident with, shipment of geomembrane to the Project site, the Owner's Representative shall review and approve submittals from the Geomembrane Manufacturer, which shall include:

- Geomembrane Manufacturer's geomembrane specification sheet(s);
- Geomembrane MQC Certificates; and
- Other information required by the technical specifications.

No geomembrane shall be installed until the Owner's Representative has reviewed all certifications and supporting test data and determined that the geomembrane furnished for the Project is acceptable for use.

5.2.2 Pre-Installation Meeting

Prior to geomembrane installation, the Owner, Owner's Representative, Owner's Professional Engineer, and Geomembrane Installer shall attend a pre-installation meeting at the Project site. At this meeting, site safety and rules of operation, scheduling, methods of installation, and construction QC shall be discussed. The Geomembrane Installer and Owner's Representative shall at this time agree to the following:

- Acceptable weather conditions for geomembrane deployment and seaming;
- Geomembrane deployment, placement, and temporary anchorage methods;
- Trial seaming procedures and characteristics of acceptable welds;

- Non-destructive testing procedures;
- Destructive testing procedures and resolution of failed destructive tests; and
- Repair procedures.

Prior to installation, the geomembrane installer shall provide the Owner with a certification letter or form accepting the prepared subgrade. This letter will be included in the certification report for the geomembrane installation as discussed in this CQA Plan.

5.2.3 Delivery, Handling, and Storage

All geomembrane delivery, handling, and unloading shall be performed in the presence of the Owner's Representative. During unloading, the Contractor and Owner's Representative shall conduct an inspection of all delivered geomembrane for defects and damage caused by inadequate or improper packaging, shipping, unloading, or handling. Geomembrane identified as having defects or damage shall be examined by the Owner's Representative to determine its acceptability. If the Owner's Representative determines that only minor, repairable defects or damages are present, the geomembrane will be kept for use, pending acceptance of MQC testing and conformance testing. If the Owner's Representative determines that significant defects or damage are present, the geomembrane shall be marked as rejected and removed from the project site.

The Owner's Representative shall review packing slips or bills of lading to verify delivery of correct materials (i.e., geomembrane type, thickness, etc.). The Owner's Representative shall also verify that roll/panel numbers listed on packing slips match the roll/panel numbers on the geomembrane labels. If discrepancies are found, the Owner's Representative shall immediately notify the Contractor. Any geomembrane that has no label or where the label is damaged or otherwise illegible may either be sampled for laboratory analysis to determine its acceptability, or rejected and removed from the project site, as directed by the Owner's Representative. The Owner's Representative shall also verify that geomembrane production lots, and associated roll/panel numbers, delivered to the project site match the production lots and roll/panel numbers recorded on the approved MQC Certificates. If discrepancies are found, the Owner's Representative shall immediately notify the Contractor.

5.2.4 Conformance Sampling and Testing

Conformance sampling and testing of the geomembrane shall be performed by the Owner's Representative in accordance with the minimum sampling frequencies and test methods outlined in Tables 1 and 2 of this CQA Plan. Conformance sampling and testing shall be completed at a minimum frequency of one sample per geomembrane production lot according to the following procedure:

- Cut a sample from the geomembrane that is 3 feet long by the full roll/panel width wide.
- Mark the sample with arrows indicating the machine direction of the geomembrane.
- Label the sample and include all pertinent project and geomembrane product information.
- Complete chain-of-custody and testing request forms and forward conformance samples to a Geosynthetics CQA Laboratory for analysis.

The Owner's Representative shall review results from all conformance testing to verify compliance with the requirements of the Technical Specifications. If all requirements are met, the Owner's Representative shall issue written acceptance of the geomembrane for deployment. If the requirements are not met, the Owner's Representative shall notify the Contractor and either resample/retest the failed roll/panel or mark the failed roll/panel as rejected. If the failed roll/panel is rejected, the Owner's Representative shall obtain conformance samples from the closest numerical roll/panel on each side of the failed roll/panel number. The two additional geomembrane samples must conform to the Technical Specifications. If either sample fails, the entire production lot will be marked as rejected and every roll/panel in the geomembrane production lots remaining on-site shall undergo conformance testing.

5.2.5 Deployment and Seaming

All geomembrane deployment and seaming operations shall be performed in the presence of the Owner's Representative and QC Team. Geomembrane shall only be deployed and seamed when weather conditions (temperature, humidity, precipitation, wind speed and direction, etc.) are within the limits established in the Technical Specifications and agreed to at the pre-installation meeting. The Owner's Representative shall document weather conditions during all geomembrane deployment and seaming operations.

All geomembrane field panels are to be labeled by the Geomembrane Installer using a unique panel "identification code" (number or letter-number combination) consistent with the labeling system agreed to during the pre-installation meeting. This identification code will be used for all CQA records. The Owner's Representative shall verify that the Manufacturer's roll/panel number and the date and time the panel are placed are marked on each of the field panels at the location(s) selected by the Owner's Representative. During geomembrane deployment, the Owner's Representative and QC Team shall verify and/or document the following:

- Geomembrane is only to be deployed on subgrade that has been installed in accordance with the Technical Specifications and the CQA Plan, and has been accepted by the Contractor, Geomembrane Installer, and Owner's Representative.
- Equipment and tools used to deploy and place geomembrane will not stretch, puncture, tear, or otherwise damage the geomembrane, and shall protect the underlying prepared subgrade from damage.
- Geomembrane is unrolled and placed in such a manner as to minimize dragging of panels into position ("spotting").
- Geomembrane is placed in the manner that minimizes or eliminates bridging ("trampolining") at the toe of slopes; orienting panel seams in a direction parallel to the line of maximum subgrade slope; shingling panels such that the "upstream" panel overlaps the "downstream" panel in order to minimize infiltration potential; and offsetting all panel seams parallel to the toe of a slope ("longitudinal seams") at the specified distance from the toe of the slope.
- Proper temporary anchorage and ballast is immediately used to prevent wind uplift, panel movement during field seaming, and bridging.
- The Geomembrane Installer's panel placement techniques and schedule minimize or eliminate the potential for accumulation of surface water runoff beneath the geomembrane. If any water is found ponded beneath the geomembrane after it has been installed, it shall be removed by the Contractor as directed by the Owner's Representative. Any compacted soil beneath installed geomembrane that has become excessively moist, soft, or unsuitable to perform its intended function, shall be removed and replaced by the Contractor as directed by the Owner's Representative.

All geomembrane panels shall be permanently seamed on the same day they are placed, except where explicitly approved by the Owner's Representative. Thermo-fusion seaming methods shall be used to join geomembrane panels in the field. For joining geomembrane panels, dual hot wedge is the preferred seaming method. For LLDPE geomembrane, extrusion welding shall be used for repairs, detailing, and other seams where thermo-fusion welding is not practical. Project seaming is a two-part process. The first part is referred to as trial seaming, where the equipment and technicians that are to perform the work are "qualified" to do so by having them prepare and evaluate test seams. The second part is referred to as production seaming, which entails the actual fabrication of field seams on deployed geomembrane panels. No production seaming shall commence until trial seaming is successfully completed and accepted by the Owner's Representative. During geomembrane seaming, the Owner's Representative and QC Team shall verify and/or document the following:

- Trial seams are prepared in the presence of the Owner's Representative or QC Team for each piece of seaming equipment in accordance with the frequencies and conditions required in the Technical Specifications. If any specimens fail to meet qualification criteria, the Owner's Representative may elect to have additional specimens from the sample tested in order to determine trial seam acceptance. If a trial seam fails to meet all qualification criteria, a new trial seam must be prepared and evaluated. If this second trial seam also fails, the seaming equipment and/or seaming technician preparing the trial seams shall not be allowed to perform production seaming until any deficiencies are corrected and two consecutive trial seams meeting all qualification criteria are prepared and accepted by the Owner's Representative.
- Geomembrane sheets that are to be production-seamed are positioned to create acceptable overlap and the overlap areas are free of dirt, dust, moisture, or other foreign material.
- All geomembrane production seams are labeled by the Geomembrane Installer with the date and time welding of the seam was started and completed, the seaming technician initials and seaming machine identification number, and all applicable seaming parameters (set temperature, rate of travel, etc.) used to prepare the seam.
- No folds, wrinkles, or "fish-mouths" are present within any seam areas. Where wrinkles or folds occur, the material shall be cut, overlapped, and a patch applied.
- The entire length (100 percent) of all production seams are non-destructively tested by the Geomembrane Installer to verify seam continuity. Non-destructive testing shall be performed in the presence of the Owner's Representative or QC Team.
- Production seam samples suitable for laboratory destructive testing are obtained by the Geomembrane Installer at locations established by the Owner's Representative as production seaming progresses. The Owner's Representative shall representatively sample all seaming equipment and welding technicians at the rates established. All samples are to be forwarded by the Owner's Representative to a Geosynthetics CQA Laboratory where they shall be destructively tested in peel and shear in accordance with ASTM D 6392.
- Review all laboratory testing data to verify that all production seam destructive testing meets the requirements of Table 3 of this CQA Plan. If any specimens fail to meet qualification criteria, the Owner's Representative may elect to have additional specimens from the sample tested in order to determine production

seam acceptance. If a destructive test sample fails to meet all qualification criteria, the Geomembrane Installer shall obtain two additional production seam samples, each a distance of approximately 10 feet in opposite directions from the original sample, for laboratory destructive testing. In order for the production seam to be accepted, the failed destructive test sample shall be bounded by two passing destructive test samples, and the seam between the two passing test locations shall be reconstructed. Alternatively, the entire length of the seam in question may be repaired by placement of a cap strip, or by another repair procedure, as directed by the Owner's Representative.

5.2.6 Repairs

During geomembrane installation, the Owner's Representative and QC Team shall visually inspect all geomembrane panels and seams for damage or defects, and shall mark any such areas for repair. The Owner's Representative shall verify that the Geomembrane Installer repairs marked areas as soon as possible and that any defects that could allow surface water runoff beneath the geomembrane are repaired on the same day they are marked. The Owner's Representative shall also verify that repairs are made in accordance with acceptable geomembrane repair methods and that all repairs are non-destructively tested.

5.2.7 Final Inspection/Covering

The Owner's Representative shall complete a final visual examination of all geomembrane panels, seams, and repairs prior to accepting the geomembrane installation. The Owner's Professional Engineer shall personally conduct a final inspection on the completed facilities for the certification. The Geomembrane Installer shall repair and test any areas identified during the Owner's Representative's final inspection as not being acceptable. No LLDPE geomembrane shall be covered with geotextile until it has been accepted by the Owner's Representative. Once accepted, LLDPE geomembrane shall be covered as soon as possible.

5.3 Geocomposite Drainage Net

Geocomposite used in the geosynthetic cap system is identified as GDN on the Drawings and in the Technical Specifications. The GDN has nonwoven geotextiles heat bonded to both sides of the high density polyethylene (HDPE) geonet.

The QC team will be responsible for completing or verifying the completion of the liner installation records completed by the Geosynthetics Installer. Forms CQA.1, CQA.3, CQA.6, and CQA.9 are provided as examples of typical installation documentation forms. These forms are for example only, alternate forms may be used to document the installation.

5.3.1 Manufacturing

The GDN Manufacturer shall provide the Owner's Representative with a list of certified properties for the type of GDN to be supplied. The GDN Manufacturer shall provide the Owner's Representative with written certification signed by a responsible party that the GDN delivered has properties, which meet or exceed the certified properties. In addition, at least two transmissivity tests on the GDN shall be performed by the QC team using the actual site materials and loading conditions. The transmissivity tests shall be performed in accordance with the procedures outlined on Table 8. The minimum transmissivity shall be as required by the Technical Specifications.

The QC team will examine all manufacturers' certifications and test results to ensure that the property values listed on the certifications meet or exceed those specified. Any deviations will be reported to the Owner's Representative.

5.3.2 Labeling

The GDN Manufacturer shall identify all rolls of GDN with the following:

- Manufacturer's name;
- Product designation;
- Lot number;
- Roll number;
- Roll dimensions and weight; and
- Geotextile orientation (leak detection GDN only).

The QC team will examine rolls upon delivery and any deviation from the above requirements will be reported to the Owner's Engineer.

5.3.3 Shipment and Storage

GDN cleanliness is essential to its performance and GDN rolls shall be wrapped in polyethylene sheets or otherwise protected against dust and dirt during shipping and storage.

The wrapping shall be removed less than one hour before placement. The QC team will verify that the GDN is free of dirt and dust just before installation. The QC team will report the outcome of this verification to the Owner's Representative, and if the GDN is judged dirty or dusty, it shall be washed by the Installer prior to installation.

Washing operations will be observed by the QC team and improper washing operations will be reported to the Owner's Representative.

5.3.4 Conformance Testing

Tests

Upon delivery of the rolls of GDN, the QC team will ensure that samples are removed and forwarded to the Geosynthetic CQA Laboratory for testing to ensure conformance to both the Specifications and manufacturer's certified properties. Conformance sampling and testing will be performed in accordance with Table 8 of this CQA Plan.

In addition to the conformance sampling shown on Table 8, the Owner's Representative shall conduct gradation testing on the soils to be used for the cover soils to verify the cover soils are stable (internally filtering) or compatible with the proposed GDN geotextile. If the cover soils are not internally filtering, they should be tested for compatibility with the GDN using hydraulic conductivity ratio testing or other testing approved by the owner's representative.

Sampling Procedures

Samples will be taken across the entire width of the roll and will not include the first 3 feet. Unless otherwise specified, samples will be 3 feet long by the roll width. The QC team will mark the machine direction on the samples with an arrow.

Test Results

The QC team will examine all results from laboratory conformance testing and will report any nonconformance to the Owner's Representative. The minimum standards for GDN are provided in Table 8 of this CQA Plan and in the Technical Specifications.

Conformance Test Failure

The following procedure will apply whenever a sample fails a conformance test that is conducted by the Geosynthetics CQA Laboratory:

- The Installer shall replace the roll of GDN that is in non-conformance with the Technical Specifications with a roll that meets the Technical Specifications; and
- The Installer shall remove conformance samples for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must conform to the Technical Specifications. If either of these samples fail, the five numerically closest untested rolls on both sides of the failed sample will be tested by the Geosynthetics CQA Laboratory. These 10 samples must conform to the Technical Specifications. If any of these samples fail, every roll of GDN on-site and every subsequently delivered roll that is from the same supplier must be tested by the Geosynthetics CQA Laboratory for conformance to the Technical Specifications. This additional conformance testing will be at the expense of the Installer.

The QC team will document actions taken in conjunction with conformance test failures.

5.3.5 Handling and Placement

Field Panel Placement

Form CQA.6 shall be completed daily.

Location

The QC team will verify that field panels are installed at the location indicated on the Installer's field installation drawings, as approved or modified.

Placement

The Installer shall handle all GDN in such a manner as to ensure that it is not damaged in any way, and the following shall be complied with:

- On slopes, the GDN shall be secured in the cap perimeter termination area and then rolled down the slope in such a manner as to continually keep the GDN in continuous contact with the geomembrane surface. If necessary, GDN shall be positioned by hand after being unrolled to minimize wrinkles.
- In the presence of wind, GDN shall be ballasted with sandbags or equivalent. Such sandbags shall be installed during placement and shall remain until replaced with overlying material.
- Unless otherwise specified, GDN shall not be welded to geomembranes. No burn-through geotextiles shall be permitted. No glue or adhesive shall be permitted.
- The Installer shall take any necessary precautions to prevent damage to the underlying layers during placement of the GDN.
- During placement of GDN, care shall be taken not to entrap dirt or excessive dust that could cause clogging of the system and/or stones that could damage the adjacent geomembrane. If dirt or excessive dust is entrapped in the GDN, it shall be hosed clean prior to placement of the next material on top of it. In this regard, care shall be taken with the handling of sandbags to prevent rupture or damage of the sandbag.
- In no instance shall equipment travel directly on the geomembrane. Only track equipment with ground pressures less than or equal to 5 pounds per square inch shall be allowed to routinely cross geomembrane or geotextile areas provided a minimum of 12 inches of cover is maintained. Rubber-tired vehicles

can occasionally cross the area as long as 18 inches of cover is maintained and the vehicle wheels do not slip. For all temporary access roads crossing a geosynthetic cap system edge, or for access roads over the geosynthetic cap system in order to end dump protective cover or waste, the contractor shall maintain a 3-foot (minimum) layer of approved cover material over the geosynthetic cap system.

The QC team will note any non-compliance and report it to the Owner's Representative.

5.3.6 Joining

Adjacent GDN panels shall be joined according to the Technical Specifications. As a minimum, the following requirements shall be met:

- A combination of lap joints (geonet) and sewing (geotextile) shall be used to join GDN panels in the field. A minimum geonet overlap of 3 inches shall be used for panel edges and a minimum GDN overlap of 24 inches shall be used for panel ends. At the panel butt ends, geotextile of the same weight as the top geotextile on the GDN shall be placed over the GDN overlap and heat bonded to the adjoining GDN panels, with a minimum overlap of 12 inches on either side.
- Thermal seaming methods may be accepted if successfully demonstrated in the field and approved by the Owner's Representative and CQA Consultant.
- Tying shall be achieved by nylon cable or HDPE fasteners. Tying devices shall be white or yellow to aid the QC team with visual inspection. Metallic devices shall not be used.
- Tying fasteners shall be spaced every 5 feet along panel edges, every 6 inches across panel ends and in corners, and every 6 inches in the perimeter geosynthetic cap system termination area. This requirement may be omitted at butt ends on flat slopes if approved by the Owner's Engineer and Manufacturer; and
- The QC team will note any non-compliance and report it to the Owner's Representative.

5.3.7 Repair

Any holes or tears in the GDN shall be repaired by placing a patch extending 12 inches beyond edges of the hole or tear. The patch shall be secured to the original GDN by tying fasteners every 6 inches. If the hole or tear width across the roll is more than 50 percent the width of the roll, the damaged area shall be cut out and the two portions of the GDN will be joined.

The QC team will observe any repair, note any non-compliance with the above requirements, and report them to the Owner's Representative.

6.0 Final Cover System Drainage

The cover system drainage components include nonwoven filter geotextile, subsurface drainage pipe and underdrain pipes as described below.

6.1 Nonwoven Filter Geotextile

Nonwoven Filter geotextile shall consist of an 8 oz./sq.yd., non-woven polypropylene geotextile, and shall conform the requirements of Table 6.

6.1.1 Conformance Sampling and Testing

Conformance sampling and testing of the geotextile shall be performed by the Owner's Representative in accordance with the minimum sampling frequencies outlined in Table 6 of this CQA Plan. Conformance testing will be completed according to the following procedure:

- Cut a sample from the geotextile that is 3 feet long by the full roll width. Do not include the first 3 feet of the roll. Mark the samples with an arrow indicating the machine direction of the geotextile.
- Label the sample and include all pertinent project and geotextile product information.
- Complete chain-of-custody and testing request forms and forward conformance samples to the Geosynthetics CQA Laboratory.

The Owner's Representative shall review results from all conformance testing to verify compliance with requirements. If all requirements are met, the Owner's Representative shall issue written acceptance of the geotextile for deployment. If the requirements are not met, the Owner's Representative shall notify the Contractor and either resample/retest the failed roll/panel or mark the failed roll/panel as rejected. If the failed roll/panel is rejected, the Owner's Representative shall obtain conformance samples from the closest numerical roll/panel on each side of the failed roll/panel number. The two additional geotextile samples must conform to Table 6 (included in this CQA Plan) for the applicable geotextile. If either sample fails, the five numerically closest untested rolls on both sides of the failed sample will be tested by the Geosynthetics CQA Laboratory. These 10 samples must conform to the Specifications. If any of these samples fail, every roll of geotextile on-site and every subsequently delivered roll that is from the same supplier must be tested by the Geosynthetics CQA Laboratory for conformance.

6.1.2 Final Inspection and Covering

The Owner's Representative shall complete a visual inspection of all geotextile panels, seams, and repairs prior to accepting the geotextile installation. The Owner's Professional Engineer shall personally conduct a final inspection on the completed facilities for the certification. The Installer shall place all material located on top of the geotextile in such a manner to ensure that there is no damage to the geotextile and geosynthetics, that there is minimal slippage of the geotextile on underlying layers, and that there is no excess tensile stresses in the geotextile.

6.2 Subsurface Drain and Underdrain Pipe

The subsurface drain piping system will consist of a network of 6 inch, 8 inch, and 12 inch diameter solid wall and perforated wall HDPE pipe, which is bedded in a coarse aggregate drainage layer and wrapped on nonwoven filter geotextile located within the soil cover. The piping system is utilized to drain soil cover infiltration water to assist in minimizing head build up on the geomembrane.

The underdrain drain piping system will consist of a network of 6-inch diameter perforated wall pipe, which is bedded in a coarse aggregate drainage layer and wrapped in underdrain geotextile, and will be located within the pond ash beneath the geosynthetic cap system. The underdrain is utilized to drain pond ash upon soil cover loading and to prevent hydrostatic uplift on the geosynthetic cap system.

Product information for the HDPE subsurface drain pipe and underdrain pipe is specified in the Technical Specifications. The Owner's Representative shall approve the HDPE pipe product information to be installed. The installation of the underdrain piping and coarse aggregate will be monitored daily by the QC Team product to verify compliance with the Drawings and Technical Specifications.

6.3 Aggregate

The material shall be clean, sound, tough, durable, angular, subangular, and free from slag, cinders, ashes, rubbish, or other deleterious material, in accordance with the VA Department of Transportation Section 203. In addition, soluble calcium carbonate of underdrain aggregate shall not exceed 10 percent by weight. Aggregate shall be placed in maximum 6-inch loose lifts. Gravel placed as pipe bedding shall be compacted, no compaction shall occur on the sides of the drain piping, and compaction shall not occur above the pipe until a minimum of 12 inches of gravel is placed above the pipe. Aggregate shall be compacted with a minimum of four passes of a plate compactor.

7.0 Final Cover System Soil Cover

The purpose of the soil cover layer is to provide freeze/thaw protection to the geosynthetics cap system, and to provide a base for establishment of vegetative cover, which aids in prohibiting damage to the geosynthetic cap system and limits surface water infiltration to minimize potential instability of the system. All ongoing activities will be monitored daily by the Owner's Representative and the QC Team.

7.1 Material

The material used to construct the Protective Cover soil and vegetative support soil layer shall be free of construction debris, cobbles and boulders, or other deleterious material.

7.2 Placement

Final cover lift placement and compaction control shall conform to all of the following requirements:

- If screening is not performed on Protective Cover Soil, the Contractor shall have a minimum of three people to remove oversized material from the Protective Cover Soil and help flatten wrinkles and prevent damage to geomembrane during placement of the first lift. If screening is performed on Protective Cover Soil, the Contractor shall have a minimum of one person to help flatten wrinkles and prevent damage to geomembrane during placement of the first lift.
- The 18-inch Protective Cover Soil Layer shall be placed in two lifts.
- The 6-inch thick Vegetative Support Layer shall be placed in one lift.

7.3 Vegetation

QC inspection activities include observation to ensure that:

- Materials provided (e.g., soil, fertilizer, seed) meet specification requirements and are acceptable based on local regulations.
- During the construction care period (a minimum of a full growing season up to an one-year warranty provision) erosion protection is maintained.
- If required, periodic irrigation is utilized to produce satisfactory growth.

Areas that fail to show a uniform stand of grass shall be reseeded, fertilized, and mulched as necessary to establish satisfactory growth.

7.4 Final Inspection

Upon completion of the final cover system, the area shall be inspected to ensure a 90 percent vegetative growth. If insufficient growth is found the area shall be reseeded, fertilized, and mulched. The Owner's Professional Engineer shall personally conduct a final inspection on the completed facilities.

8.0 Miscellaneous Construction

8.1 Common Fill

The purpose of common fill is to provide soil for general site grading and backfill. All ongoing activities will be monitored daily by the Owner's Representative and the QC Team. Common fill will not contain unsuitable material, as defined in the Technical Specifications, or CCRs, as defined in Section 4.0. Common fill placement and monitoring requirements are provided in Tables 12 and 13.

8.2 Structural Fill

The purpose of the structural fill layer is to provide backfill materials for anchor trenches, as indicated, and concrete structures, for embankment construction of basins or ponds, foundation material for cellular concrete mattresses, or as designated on the drawings. All ongoing activities will be monitored daily by the Owner's Representative and the QC Team. Structural fill will not contain unsuitable material or contaminated material, as defined in Section 3.0, or CCRs, as defined in Section 4.0. Structural fill placement and monitoring requirements are provided in Tables 2 and 13.

8.3 Separation Geotextile

Separation geotextile shall consist of a 12 oz./sq.yd. non-woven polypropylene geotextile, and shall conform to the requirement of Table 7.

8.3.1 Conformance Sampling and Testing

Conformance sampling and testing of the geotextile shall be performed by the Owner's Representative in accordance with the minimum sampling frequencies outlined in Table 7 of this CQA Plan. Conformance testing will be completed according to the following procedure:

- Cut a sample from the geotextile that is 3 feet long by the full roll width. Do not include the first 3 feet of the roll. Mark the samples with an arrow indicating the machine direction of the geotextile.
- Label the sample and include all pertinent project and geotextile product information.
- Complete chain-of-custody and testing request forms and forward conformance samples to the Geosynthetics CQA Laboratory.

The Owner's Representative shall review results from all conformance testing to verify compliance with requirements. If all requirements are met, the Owner's Representative shall issue written acceptance of the geotextile for deployment. If the requirements are not met, the Owner's Representative shall notify the Contractor and either resample/retest the failed roll/panel or mark the failed roll/panel as rejected. If the failed roll/panel is rejected, the Owner's Representative shall obtain conformance samples from the closest numerical roll/panel on each side of the failed roll/panel number. The two additional geotextile samples must conform to Table 7 (included in this CQA Plan) for the applicable geotextile. If either sample fails, the five numerically closest untested rolls on both sides of the failed sample will be tested by the Geosynthetics CQA Laboratory. These 10 samples must conform to the specifications. If any of these samples fail, every roll of geotextile on-site and every subsequently delivered roll that is from the same supplier must be tested by the Geosynthetics CQA Laboratory for conformance.

8.3.2 Final Inspection and Covering

The Owner's Representative shall complete a visual inspection of all geotextile panels, seams, and repairs prior to accepting the geotextile installation. The Installer shall place all material located on top of the geotextile in such a manner to ensure that there is no damage to the geotextile and geosynthetics, that there is minimal slippage of the geotextile on underlying layers, and that there is no excess tensile stresses in the geotextile.

9.0 Documentation and Certification

9.1 Introduction

An effective CQA Plan depends largely on recognition of all construction activities that should be monitored, and on assigning responsibilities for the monitoring of each activity. This is most effectively accomplished and verified by the documentation of QC activities. The Owner's Representative shall document that QC requirements have been addressed and satisfied. The Owner's Representative or QC Team shall be responsible for completing daily logs and data sheets to verify that all monitoring activities have been carried out. The Owner's Representative or QC Team shall also maintain, at the job site, a complete file of design plans, design specifications, the CQA Plan, checklists, test procedures, daily logs, and other pertinent documents. Sample CQA forms, which the QC Team or Geosynthetics Installer will be required to complete, are included in this CQA Plan. Similar forms may be used in lieu of these sample CQA forms.

9.2 Certification of Major Construction Activities

The Owner's Engineer shall prepare a certification report at the completion of construction. The major construction activities to be documented in the certification report include the following:

- Low Permeability Soil Liner;
- Prepared Subgrade Surface;
- GCL Installation;
- Cushion Geotextile Installation;
- Geomembrane Installation;
- GDN Installation;
- Drain Pipe/Trench Installation; and
- Soil Cover.

The certification shall describe activities associated with the construction of the item, including construction procedures, observations, and tests performed by the QC Team. At a minimum, the certification report shall include:

- Summaries of construction activities;
- Observation logs and test data sheets including sample location plans, and supporting field and laboratory test results;
- Construction problems and solutions reports;
- Changes from design and material specifications;
- As-built drawings; and

- The certification report shall be signed and sealed by the Owner's Engineer (PE registered in VA).

The as-built drawings shall include scale plans depicting the location of the construction, and details pertaining to the extent of the construction (e.g., depths, plan dimensions, elevation, soil component thicknesses, etc.). Surveying and base maps required for development of the as-built drawings shall be prepared by the Contractor's Professional Licensed Surveyor. The drawings shall specifically identify any significant deviations from the permit drawings and shall be prepared in the coordinate system used by the construction drawings.

9.3 Storage of Records

Data sheets, reports, and other relevant documentation shall be compiled in a single document and stored on-site. Other reports may be stored by any standard method that allows for easy access.

10.0 Surveying

Surveying of lines and grades shall be conducted on an ongoing basis during construction of the soil layers, pipe, and geosynthetics placement. Surveying is to provide documentation for record drawings and verify construction. The Owner's Engineer, or his representative, will perform periodic inspections, and will review and approve as-built plans. The Owner's Representative will only spot check the work as he deems necessary. The surveying conducted at the site shall be the responsibility of the contractor. The surveyor and contractor shall remove all stakes from the geosynthetic cap area immediately after they are broken or no longer required for grade control. They must assure that no stakes will be in the fill below or above the liner.

10.1 Survey Control

Permanent benchmarks will be established for the site at a location convenient for daily tie-in. The vertical and horizontal controls for these benchmarks will be established within normal land surveying standards.

10.2 Surveying Personnel

All surveying shall be performed under the direct supervision of a Professional Licensed Surveyor. All survey results shall be certified by a VA registered professional land surveyor.

10.3 Precision and Accuracy

A wide variety of survey equipment is available to meet the requirements of this project. The survey instruments used for this work shall be sufficiently precise and accurate to attain third order survey for traverse and leveling surveys. All survey instruments should be capable of distance measurements to a precision of 0.01-foot and with angle readings of 20 sec.

10.4 Conformance Survey Requirements

Tolerances, Lines, Grades and the necessary conformance surveys and record drawings are specified in the Construction Specifications.

10.5 Documentation

All field survey notes will be retained by the Owner's Representative. A copy of these reduced notes shall be given to the Owner at the end of the surveying task. The results from the field surveys shall be documented on a set of Survey Record Drawings compatible in AutoCad, Format Release 2010 or newer, including point blocks and contours, where applicable. These drawings should at least include all of the information required in this document. The drawings will be updated by the Owner's Engineer if required.

SAMPLE CQA FORMS

GAI Consultants, Inc.
385 East Waterfront Drive
Homestead, PA 15120
(412) 476-2000
(412) 476-2020 (FAX)

CQA.1

DAILY PROGRESS REPORT

For Example Only

PAGE _____ OF _____

DATE:	PROJECT NO.: C150132.00	REPORT NO.:
PROJECT: Impoundment Closure Project		
LOCATION: Possum Point Power Station, Prince William County VA	CQA TIME ON-SITE: ARRIVE: DEPART:	
CONTRACTOR(S):	SUBCONTRACTOR(S):	
WEATHER: AM: PM:		
EQUIPMENT:		
MANPOWER: PRIME: __ SUPER'S, __ FOREMEN, __ OPERATORS, __ LABORERS, OTHER ______ OTHER CONTRACTORS: ______		

THE FOLLOWING WAS NOTED: ______

CC:

______
CQA REPRESENTATIVE

______
DOMINION REPRESENTATIVE

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For Example Only

CQA.2

FIELD DENSITY TESTING RECORD (NUCLEAR METHOD)

PROJECT: Impoundment Closure Project – Possum Point Power Station PROJECT NO.: C150132.00 DATE:________________

CQA TECHNICIAN:________________ GAUGE NO.:________ STD. COUNTS: ________(MOISTURE) ________(DENSITY)

TEST NO.	LIFT / ELEV.	LOCATION	SOIL DESCRIPTION (COLOR & TYPE, LIFT THICKNESS, ETC)	FIELD DENSITY			PROCTOR DENSITY		% COMPACTION			COMMENTS
				γ_{wet} (pcf)	w (%)	γ_{dry} (pcf)	MAX. γ_{dry} (pcf)	OPT. W (%)	FIELD	REQ.	P / F	

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For Example Only

CQA.3

GEOSYNTHETICS RECEIVING / FIELD INVENTORY RECORD

PROJECT: Impoundment Closure Project – Possum Point Power Station PROJECT NO.:C150132.00

INVENTORY DATE/TIME:__________ CQA TECHNICIAN:__________

WEATHER CONDITIONS:__________

STORAGE AREA LOCATION & CONDITIONS:__________

CARRIER:__________ SHIPMENT NO.:__________

DRIVER:__________ DELIVERY DATE/TIME:__________

UNLOADED BY:__________ EQUIPMENT:__________

COMMENTS:__________

MANUFACTURER:__________ PRODUCT:__________

	BATCH / LOT NUMBER	ROLL NUMBER	DIMENSIONS		CONFORMANCE SAMPLE NUMBER	DAMAGE / COMMENTS
			WIDTH (ft)	LENGTH (ft)		
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						

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For Example Only

SUBBASE ACCEPTANCE RECORD

PROJECT: Impoundment Closure Project – Possum Point Power Station PROJECT NO.: C150132.00

LOCATION: Possum Point Power Station, Prince William County VA

EARTHWORK CONTRACTOR

NAME:__________ ADDRESS:__________

CITY:__________ STATE:_____ ZIP:__________

PROJECT SUPERINTENDENT:__________ PHONE:__________

GEOSYNTHETICS INSTALLER

NAME:__________ ADDRESS:__________

CITY:__________ STATE:_____ ZIP:__________

PROJECT SUPERINTENDENT:__________ PHONE:__________

SUBBASE ACCEPTANCE CERTIFICATION

DATE:__________ TIME:__________ REF. SKETCH:__________

This form documents that the Subbase delineated on the attached sketch is acceptable for installation of GCL and secondary HDPE geomembrane. The Subbase has been prepared in accordance with the Contract Drawings and Specifications and has been inspected and approved by the parties below at the date and time listed above. Any changes in Subbase conditions due to weather, vehicular traffic, or other causes will require re-approval of the affected areas after necessary repairs are completed. This document only applies to the Subbase surface and does not constitute acceptance of the GCL and secondary HDPE geomembrane installation.

EARTHWORK CONTRACTOR SIGNATURE:__________ DATE:__________

PRINT NAME:__________

PRINT TITLE:__________

GEOSYNTHETICS INSTALLER SIGNATURE:__________ DATE:__________

PRINT NAME:__________

PRINT TITLE:__________

CQA CONSULTANT SIGNATURE:__________ DATE:__________

PRINT NAME:__________

PRINT TITLE:__________

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For Example Only

CQA.5

GEOMEMBRANE TRIAL SEAM RECORD

PROJECT: Impoundment Closure Project

PROJECT NO.: C150132.00 DATE:____________

LOCATION: Possum Point Power Station, Prince William County, VA

CQA TECHNICIAN:____________

CONTRACTOR:____________

INSTALLER:____________

FUSION WELDS — PROJECT CRITERIA (lbs): 90 (PEEL) 112 (SHEAR)

TIME	AMB. TEMP.	SEAMING TECH.	MACHINE NO.	WEDGE TEMP.		TRAVEL SPEED		PEEL (lbs)					SHEAR (lbs)		P / F	COMMENTS
				SET	ACTUAL	SET	ACTUAL	1	2	3	4	5	1	2		

EXTRUSION WELDS — PROJECT CRITERIA (lbs): 81 (PEEL) 112 (SHEAR)

TIME	AMB. TEMP.	SEAMING TECH.	MACHINE NO.	BARREL TEMP.		PREHEAT TEMP.		PEEL (lbs)					SHEAR (lbs)		P / F	COMMENTS
				SET	ACTUAL	SET	ACTUAL	1	2	3	4	5	1	2		

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For Example Only

CQA.6

GEOSYNTHETICS DAILY PLACEMENT RECORD

PROJECT: Impoundment Closure Project

LOCATION: Possum Point Power Station, Prince William County VA

PROJECT NO.: C150132.00

MATERIAL: ____________________

CQA TECHNICIAN: ____________________

DATE	TIME	PANEL NUMBER	ROLL NUMBER	PANEL LENGTH (ft)	PANEL WIDTH (ft)	PANEL AREA (ft^2)	COMMENTS

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GEOMEMBRANE PANEL INSPECTION RECORD

SYMBOLS / SYMBOL DEFINITIONS

ZONE 1	AIR PRESSURE ZONE
○	REPAIR NEEDED
⊗	REPAIR COMPLETED
●	REPAIR TESTED
	REPAIR APPROVED
	DESTRUCTIVE SAMPLE REPAIR
	CAP STRIP REPAIR
	EXTRUSION WELD

DEFECT CODES / DEFECT CODE DEFINITIONS

BT	BURN THROUGH
CR	CREASE
DS-1	DESTRUCTIVE SAMPLE & NO.
ED	CONST. EQUIPMENT DAMAGE
FM	FISH MOUTH
PTC	PRESSURE TEST CUT
SI	SOIL SURFACE IRREGULARITY
T	JOINT (SEAM INTERSECTION)
VL	VACUUM TEST LEAK
WK	WRINKLE
WR	WELDER RESTART

GENERAL CODES / GENERAL CODE DEFINITIONS

AT	ANCHOR TRENCH
EOS	END OF SEAM
VBT	VACUUM BOX TESTED
DTF	DUAL TRACK FUSION
SWW	SINGLE WEDGE WELD
EXT	EXTRUSION WELD

For Example Only

GEOMEMBRANE SEAM INSPECTION RECORD

PROJECT: Impoundment Closure Project - Possum Point Power Station

PROJECT NO.: C150132.00

CONTRACTOR: .

INSTALLER:

COMMENTS:

□ FINAL INSPECTION/ACCEPTED

SEAM NO.:

DATE WELDED:

TIME WELDED: A.M./P.M.

SEAMING TECH.:

MACHINE NO.:

WELDING MACHINE TYPE:

SEAM LENGTH:

SEAM DETAIL (Show Panels & Dimensions)

1. Air Pressure Testing

Zone	Length (ft)	Start Time	Start Pressure (psi)	End Time	End Pressure (psi)	Pressure Loss (psi)	Approved (Y/N)	Approved By

2. Vacuum Box Testing

Zone	Length (ft)	Date Tested	Approved (Y/N)	Date Repaired	Date Retested	Approved By

3. Seam Repairs (Patches and Cap Strips)

REPAIR NO.	DEFECT TYPE	REPAIR DATE	NDT TYPE & DATE	APPROVED BY

PAGE _____ OF _____

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For Example Only

CQA.9

GEOSYNTHETICS DAILY SUMMARY REPORT

PROJECT: Impoundment Closure Project – Possum Point Power Station

PROJECT NO.: C150132.00

CONTRACTOR: ____________________

INSTALLER: ____________________

DATE: ____________________

AMBIENT TEMPERATURE RANGE: ____________________

WEATHER CONDITIONS: ____________________

	INSTALLED TODAY (SF)	TOTAL TO DATE (SF)
Underdrain Geotextile		
GCL		
Cushion Geotextile		
Textured 40-mil LLDPE		
GDN		
Nonwoven Fitter Geotextile		
Separation Geotextile		
CCM Geotextile		
Microgrid		

WELDING TECH	SEAM LENGTHS (LF)	TOTAL LF SEAMED	D.S. NO.	D.S. SEAM NO.	DATE TO LAB	RESULT	RESULT DATE

LF SEAMED TODAY: S__________ P__________ LF SEAMED TO DATE: S__________ P__________

D.S. SAMPLING RATE = LF SEAMED TO DATE / D.S. SAMPLES TO DATE: S__________ P__________

DETAILED TODAY	S______% P______%	TOTAL TO DATE: S______% P______%
AIR TESTED TODAY (PASSING)	S______% P______%	TOTAL TO DATE: S______% P______%
V-BOXED TODAY (PASSING)	S______% P______%	TOTAL TO DATE: S______% P______%

COMMENTS: ____________________

____

CQA REPRESENTATIVE SIGNATURE

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TABLES

Table 1.
CQA Conformance Sampling and Testing Requirements for Geomembrane.

Test[(1),(2)]	Frequency and Timing	Acceptance Parameters	Test Failure Procedures
Core Thickness (ASTM D5994)	At least one per 500,000 square feet (ft^2) prior to installation	38 mil (min ave)[(3)]	Reject/replace non-conforming material and test replacement material
Tensile Properties (ASTM D6693, Type IV)-Break Strength Break Elongation	At least one per 500,000 ft^2 prior to installation	103 ppi (min ave) 400 percent (min ave)	Reject/replace non-conforming material and test replacement material
Tear Strength (ASTM D1004)	At least one per 500,000 ft^2 prior to installation	22 pounds (lbs) (min ave)	Reject/replace non-conforming material and test replacement material
Puncture Resistance (ASTM D4833)	At least one per 500,000 ft^2 prior to installation	48 lbs (min ave)	Reject/replace non-conforming material and test replacement material
Interface Shear Strength (ASTM D5321)	At least one per 500,000 ft^2 (two minimum) prior to installation	See Table 2 of this CQA Plan	Reject/replace non-conforming material and test replacement material
Asperity Height (ASTM 7466)	At least one per 500,000 ft^2 prior to installation	16 mil (min ave)[(4)]	Reject/replace non-conforming material and test replacement material
Density (ASTM D1505/D792)	At least one per 500,000 ft^2 prior to installation	0.939 g/cc (max ave)	Reject/replace non-conforming material and test replacement material
Carbon Black Content (ASTM D1603)	At least one per 500,000 ft^2 prior to installation	2.0 to 3.0 percent	Reject/replace non-conforming material and test replacement material

Notes:

1 The required properties specified herein may be revised by the Engineer to reflect new or revised test methods or to conform with improvements to the state-of-the-practice.

2 Number of specimens per test established in applicable test method unless otherwise noted.

3 Lowest individual value for eight out of 10 readings = 54 mil; lowest individual value for one out of 10 readings = 31 mil.

4 Alternate side of sheet measured each time a roll is tested.

Table 2.
Interface Shear Strength Requirements for Textured 40 Mil LLDPE Geomembrane. [1, 2, 3]

<table>
<tr><th colspan="3">Testing Set-Up</th></tr>
<tr><td rowspan="5">ASTM D5321</td><td>Conditioning:</td><td>Set up each test to match field placement orientation. Run all tests under wet conditions.</td></tr>
<tr><td>Procedure A:</td><td>Geomembrane against Cushion Geotextile
Substrate: Project Cushion Geotextile
Superstratum: Project Textured 40 Mil LLDPE Geomembrane
Displacement Rate: 0.04-inch per minute (ipm) (maximum)
Total Displacement: 2.50-inch (minimum)</td></tr>
<tr><td>Procedure B:</td><td>Geomembrane against GDN
Substrate: Project textured 40 Mil LLDPE Geomembrane
Superstratum: Project GDN
Displacement Rate: 0.04 ipm (maximum)
Total Displacement: 2.50 inches (minimum)</td></tr>
<tr><td>Procedure C:</td><td>Geomembrane against Prepared Subgrade
Substrate: Project Textured 40 Mil LLDPE Geomembrane
Superstratum: Project Prepared Subgrade
Displacement Rate: 0.04 ipm (maximum)
Total Displacement: 2.50 in (minimum)</td></tr>
<tr><td>Special Instructions:</td><td>None.</td></tr>
</table>

<table>
<tr><th colspan="2">Strength Requirements</th></tr>
<tr><th>Normal Stress [Pounds per Square Foot (psf)]</th><th>Minimum Peak Shear Strength</th></tr>
<tr><td>150</td><td rowspan="4">20 degrees</td></tr>
<tr><td>300</td></tr>
<tr><td>600</td></tr>
<tr><td>1000</td></tr>
</table>

Notes:

1. Test individual interfaces between Steel rasp platens. In lieu of testing individual interfaces, a system test may be performed using a configuration that allows failure to occur through the weakest shearing plane. System test configuration, conditions, and procedures must be accepted by the Engineer prior to submitting test results for review and approval.
2. Interfaces shall be saturated for a minimum of 24 hours prior to testing.
3. Geosynthetics shall be oriented such that the shear force is parallel to the down slope orientation of these components in the field.

Table 3.
Seam Qualification Criteria for Textured 40 Mil-LLDPE Geomembrane. (1)

	Trial Seaming(2,4,6)	Production Seaming(3,5,6,7)
Hot Wedge Seams		
Peel Strength (lbs)	50	50
Peel Incursion (%)	25	25
Shear Strength (lbs)	60	60
Shear Elongation at Break (%)	-	50
Extrusion Fillet Seams		
Peel Strength (lbs)	44	44
Peel Incursion (%)	25	25
Shear Strength (lbs/in)	60	60
Shear Elongation at Break (%)	-	50

Notes:

1 Peel strengths, shear strengths, and shear elongations listed are minimum required values. Peel incursion percentages listed are maximum allowable values.

2 Trial seams shall be prepared for each piece of seaming equipment whenever any of the following conditions occur:

- Shift start-up;
- Every four to six hours of continuous seaming within a shift;
- "Cold" restart of seaming equipment;
- Change in welding technician;
- Significant change in geomembrane sheet temperatures; and
- As required by the Owner's Representative.

3 Laboratory test in accordance with ASTM D6392.

4 For trial seaming, in order to be considered qualified, five trial seam test specimens must meet all strength and incursion requirements.

5 For production seaming, values listed for shear and peel are for four out of five test specimens; the fifth specimen can be as low as 80 percent of the listed value.

6 Seam tests for peel and shear must fail in the Film Tear Bond-mode. This is a failure in the ductile mode of one of the bonded sheets by tearing or breaking prior to complete separation of the bonded area.

7 Where applicable, both tracks of a double hot wedge seam shall be tested for peel adhesion.

Table 4.
CQA Conformance Sampling and Testing Requirements for Geocomposite Clay Liner. [(1)]

Material Property	Test Method	Test Frequency [$ft^2(m^2)$][(2)]	Required Values
Bentonite Swell Index[(3)]	ASTM D 5890	At least one per 500,000 ft^2 prior to installation	24 ml/2g min.
Bentonite Fluid Loss[(3)]	ASTM D 5891	At least one per 500,000 ft^2 prior to installation	18 ml max.
Bentonite Mass/Area[(3)]	ASTM D 5993	At least one per 500,000 ft^2 prior to installation	0.75 lb./ft^2 (3.6 kg/m^2) min.
GCL Tensile Strength[(4)]	ASTM D 6768	At least one per 500,000 ft^2 prior to installation	50 lbs/in (53 N/cm) MARV
GCL Peel Strength[(4)]	ASTM D 6496	At least one per 500,000 ft^2 prior to installation	3.5 lbs/in (6.1 N/cm) min.
GCL Hydraulic Conductivity [(5)]	ASTM D 5887	At least one per 500,000 ft^2 prior to installation	5 x 10-9 cm/sec max.
GCL Hydrated Internal Shear Strength[6]	ASTM D 5321 ASTM D 6243	At least one per 500,000 ft^2 prior to installation	500 psf. (24 kPa) typ @ 200 psf

Notes:

1. The required properties specified herein are satisfied by the Bentomat DN as manufactured by CETCO Lining Technologies but may be revised by the Engineer to reflect new or revised test methods or to conform with improvements in state-of-the practice.
2. Number of specimens per test established in applicable test method unless otherwise noted.
3. Perform tests on as-received material before incorporation into finished GCL.
4. All tensile strength testing is performed in the machine direction using ASTM D6768. All peel strength testing is performed using ASTM D6496.
5. Permeability testing with de-aired distilled/deionized water at 80 psi (551kPa) cell pressure, 77 psi (531kPa) headwater pressure and 75 psi (517kPa) tailwater pressure.
6. Peak value measures at 200 psf normal stress for a specimen hydrated for 48 hours.

Table 5a.
CQA Conformance Sampling and Testing Requirements for Cushion Geotextiles.

Test(1), (2)	Frequency and Timing	Acceptance Parameters	Sample Location(3)	Test Failure Procedures
Weight (ASTM D5261)	At least one per 500,000 ft^2 prior to installation	12 oz./sq. yd. minimum	On-site material stockpile	Reject/replace non-conforming material and test replacement material
Grab Tensile Strength (ASTM D4632)	At least one per 500,000 ft^2 prior to installation	300 lbs.	On-site material stockpile	Reject/replace non-conforming material and test replacement material
Grab Elongation (ASTM D4632)	At least one per 500,000 ft^2 prior to installation	50 percent	On-site material stockpile	Reject/replace non-conforming material and test replacement material
Trapezoidal Tear Strength (ASTM D4533 in machine and cross-machine directions)	At least one per 500,000 ft^2 prior to installation	115 lbs.	On-site material stockpile	Reject/replace non-conforming material and test replacement material
Puncture Strength (ASTM D6241)	At least one per 500,000 ft^2 prior to installation	800 lbs.	On-site material stockpile	Reject/replace non-conforming material and test replacement material
Minimum Interface Shear Strength (ASTM D5321)	At least one per 500,000 ft^2 (two minimum) prior to installation	See Table 5b of this CQA Plan	On-site material stockpile	Reject/replace non-conforming material and test replacement material

Notes:

1 The required properties specified herein may be revised by the Engineer to reflect new or revised test methods or to conform with improvements to the state-of-the practice.

2 Number of specimens per test established in applicable test method unless otherwise noted

3 The CQA Team may elect to have the Project material sampled at the manufacturer's factory and shipped to an independent testing laboratory for conformance testing.

1205

Table 5b.
Interface Shear Strength Requirements for Cushion Geotextile. [(1)]

<table>
<tr><th colspan="3">Testing Set-Up</th></tr>
<tr><td rowspan="3">ASTM D5321</td><td>Conditioning:</td><td>Set up each test to match field placement orientation. Run all tests under wet conditions.</td></tr>
<tr><td>Procedure A:</td><td>Cushion Geotextile against Prepared Subgrade
Substrate: Prepared Subgrade Soil Compacted Simulating Field Conditions
Superstratum: Project Cushion Geotextile
Displacement Rate: 0.04 ipm (maximum)
Total Displacement: 2.50 inches (minimum)</td></tr>
<tr><td>Special Instructions:</td><td>None.</td></tr>
<tr><th colspan="3">Strength Requirements</th></tr>
<tr><th colspan="2">Normal Stress [Pounds per Square Foot (psf)]</th><th>Minimum Peak Shear Strength</th></tr>
<tr><td colspan="2">150</td><td rowspan="4">20 degrees</td></tr>
<tr><td colspan="2">300</td></tr>
<tr><td colspan="2">600</td></tr>
<tr><td colspan="2">1000</td></tr>
</table>

Note:

1 Test individual interfaces between Steel rasp platens. In lieu of testing individual interfaces, a system test may be performed using a configuration that allows failure to occur through the weakest shearing plane. System test configuration, conditions, and procedures must be accepted by the Engineer prior to submitting test results for review and approval.

Table 6.
CQA Conformance Sampling and Testing Requirements for Nonwoven Filter Geotextile.

Test[(1), (2)]	Frequency and Timing	Acceptance Parameters	Sample Location[(3)]	Test Failure Procedures
Weight (ASTM D5261)	One per 40 rolls prior to installation	8 oz./sq. yd. minimum	On-site material stockpile	Reject/replace non-conforming material and test replacement material
Grab Tensile Strength (ASTM D4632)	One per 40 rolls prior to installation	205 lbs	On-site material stockpile	Reject/replace non-conforming material and test replacement material
Trapezoidal Tear Strength (ASTM D4533 in machine and cross-machine directions)	One per 40 rolls prior to installation	85 lbs	On-site material stockpile	Reject/replace non-conforming material and test replacement material
Puncture Strength (ASTM D6241)	One per 40 rolls prior to installation	535 lbs	On-site material stockpile	Reject/replace non-conforming material and test replacement material
Apparent Opening Size (mm) ASTM D 4751	One per 40 rolls prior to installation	0.18 mm Max	On-site material stockpile	Reject/replace non-conforming material and test replacement material
Permittivity (ASTM D4491)	One per 40 rolls prior to installation	1.3 sec^{-1}	On-site material stockpile	Reject/replace non-conforming material and test replacement material

Notes:

1. The required properties specified herein may be revised by the Engineer to reflect new or revised test methods or to conform with improvements to the state-of-the practice.
2. Number of specimens per test established in applicable test method unless otherwise noted
3. The CQA Team may elect to have the Project material sampled at the manufacturer's factory and shipped to an independent testing laboratory for conformance testing.

Table 7.
CQA Conformance Sampling and Testing Requirements for Separation Geotextile. (1, 2, 3, 4)

Weight (ASTM D5261)	One per 40 rolls prior to installation	12 oz./sq. yd. nominal	Sample Location	Reject/replace non-conforming material and test replacement material
Grab Tensile Strength (ASTM D4632)	One per 40 rolls prior to installation	315 lbs	On-site material stockpile	Reject/replace non-conforming material and test replacement material
Grab Elongation (ASTM D4632)	One per 40 rolls prior to installation	50 percent	On-site material stockpile	Reject/replace non-conforming material and test replacement material
Trapezoidal Tear Strength (ASTM D4533 in machine and cross-machine directions)	One per 40 rolls prior to installation	115 lbs	On-site material stockpile	Reject/replace non-conforming material and test replacement material
Puncture Strength (ASTM D6241)	One per 40 rolls prior to installation	850 lbs	On-site material stockpile	Reject/replace non-conforming material and test replacement material
Apparent Opening Size (maxARV) (ASTM D4751)	One per 40 rolls prior to installation	0.150 mm	On-site material stockpile	Reject/replace non-conforming material and test replacement material

Notes:

Nonwoven.

1 The required properties specified herein may be revised by the Engineer to reflect new or revised test methods or to conform with improvements to the state-of-the practice.

2 Number of specimens per test established in applicable test method unless otherwise noted.

3 The CQA Team may elect to have the Project material sampled at the manufacturer's factory and shipped to an independent testing laboratory for conformance testing.

Table 8.
CQA Conformance Sampling and Testing Requirements for GDN.(1)

Property (Units)	CQA Sampling Frequency (minimum)	Test Method(2)	Required Value
Finished HDPE Geonet			
Density (g/cc)	Every 500,000 ft^2	ASTM D 1505 or ASTM D 792	0.940 (min ave)
Thickness (mil)	Every 500,000 ft^2	ASTM D 5199	270.0 ± 15 (range)(3)
Finished GDN(4)			
100- hr Transmissivity (m^2/sec)	Every 500,000 ft^2	ASTM D 4716	4.1 x 10-4 (MARV)(5)
Ply Adhesion (lb/in)	Every 500,000 ft^2	ASTM D 7005	1.0 (MARV)(6)(7)
Interface Shear Strength	Every 500,000 ft^2	ASTM D 5321	See Table 9(8)

Notes:

1 The required properties specified herein may be revised by the Engineer to reflect new of revised test methods or to conform with improvements to the state-of-the practice.

2 Number of specimens per test established in applicable test method unless otherwise noted.

3 Diameter of presser foot shall be 2.22 inches and pressure shall be 2.9 pounds per square inch. Lowest individual value = 255 mil.

4 Nonwoven geotextile heat-bonded to both sides.

5 Perform test using rigid platens for substrate and cover soil compacted per the specifications for the superstratum. Test conditions: Normal stress = 300 pounds per square foot; Hydraulic gradient = 0.25; Seating period = 100 hours.

6 MARV is statistically defined as mean minus two standard deviations and it is the value, which is exceeded by 97.5 percent of all the test data.

7 Average of five equally spaced tests across the roll width.

8 Lowest individual value = 0.5-pound per inch (lb/in).

Table 9.
Interface Shear Strength Testing Requirements for GDN. (1, 2, 3, 4)

<table>
<tr><th colspan="3">Testing Set-Up</th></tr>
<tr><td rowspan="4">Standard Test</td><td>Conditioning and Set-up:</td><td>Set up each test to match field placement orientation. Run all tests under wet conditions.</td></tr>
<tr><td>Procedure A:</td><td>GDN against Geomembrane
Substrate: Project Textured 40 Mil LLDPE Geomembrane
Superstratum: Project GDN
Displacement Rate: 0.04-ipm (maximum)
Total Displacement: 2.5 inches (minimum)</td></tr>
<tr><td>Procedure B:</td><td>GDN against Site Protective Cover Soil
Substrate: Project GDN
Superstratum: Site Protective cover soil at 90% Standard Proctor MDD ± 3% OMC
Displacement Rate: 0.04-ipm (maximum)
Total Displacement: 2.5 inches (minimum)</td></tr>
<tr><td>Special Instructions:</td><td>None.</td></tr>
</table>

<table>
<tr><th colspan="2">Strength Requirements</th></tr>
<tr><th>Normal Stress [Pounds per Square Foot (psf)]</th><th>Minimum Peak Shear Strength</th></tr>
<tr><td>150</td><td rowspan="4">20 Degrees</td></tr>
<tr><td>300</td></tr>
<tr><td>600</td></tr>
<tr><td>1000</td></tr>
</table>

Notes:

1. Test individual interfaces between Steel rasp platens. In lieu of testing individual interfaces, a system test may be performed using configuration that allows failure to occur through the weakest shearing plane. System test configuration, conditions, and procedures must be accepted by the Engineer prior to submitting test results for review and approval.
2. Geosynthetics shall be oriented such that the shear force is parallel to the down slope orientation of these components in the field.
3. Interfaces shall be saturated for a minimum of 24 hours prior to testing.
4. Testing to be performed in accordance with ASTM 5321 utilizing the test conditions and procedures outlined. GDN is not acceptable if geotextile delaminates from the geonet, even if required strengths are attained.

Table 10.
CQA Conformance Sampling and Testing Requirements for Underdrain Geotextile.

Property (Units)	Testing Frequency (Minimum)	Test Method	Required Value
Structure	**Hybrid Monolithic Woven-Nonwoven Needle-punched**		
Mass per unit Area (oz./sq yd)	One per 40 rolls prior to installation	ASTM D 5261	14 (min)
Grab Tensile Strength (lb)	One per 40 rolls prior to installation	ASTM D 4632	200 (min)
Tear Strength (lb)	One per 40 rolls prior to installation	ASTM D 4533	85 (min)
Puncture Strength (lb)	One per 40 rolls prior to installation	ASTM D 6241	775 (min)
Permittivity (sec-1)	One per 40 rolls prior to installation	ASTM D 4491	0.3 (min)
Apparent Opening Size (mm)	One per 40 rolls prior to installation	ASTM D 4751	0.088 (Max)

Table 11.
Test Procedures for the Evaluation of Aggregates.

Test Method	To Determine	Test Standard
Laboratory Test Procedures		
Sieve Analysis	Particle Size Distribution of Course-Grained Soils	ASTM D422 (wet) or ASTM C 136
Unified Soil Classification System (USCS)	USCS Textural Classification	ASTM D2487
Calcium Carbonate	To Determine Calcium Carbonate Content of Aggregate	ASTM D3042
Soundness	Determination of soundness of aggregates by use of sodium or magnesium sulfate	ASTM T104
Relative Density	Relative Density	ASTM D4253 ASTM D4254
Field Test Procedures		
Soil Description	Identification of Aggregate	ASTM D2488
Ruler, Scale or Elevation Reading	Lift Depths	--

Table 12.
Pre-Qualification Testing for Soils.

Test	Standard	Frequency	Material
Sieve Analysis With Hydrometer	ASTM D422	One per source or visual change	Protective Cover Soil, Vegetative Support, Structural Fill, Low Permeability Soil Liner
Atterberg Limits	ASTM D4318	One per source or visual change	Protective Cover Soil, Vegetative Support Soil, Structural Fill, Low Permeability Soil Liner
Unified Soil Classification	ASTM D2487	One per source or visual change	Protective Cover Soil, Vegetative Support Soil, Structural Fill, Low Permeability Soil Liner
Moisture/Density Relationship	ASTM D698	One per source or visual change	Subgrade Fill, Protective Cover Soil, Vegetative Support Soil, Structural Fill, Low Permeability Soil Liner, Common Fill
Permeability(1)	ASTM D5084	One per source or visual change	Low Permeability Soil Liner

Note:

1 At 90 or 95 percent D698 maximum dry density (as determined by test pad) at optimum moisture content (OMC) to OMC +3 percent.

Table 13.
Requirements, Frequency, and Acceptance Criteria for Monitoring of Soils.

Item	Requirement	Minimum Test Frequency/Observation	Acceptance Criteria
1. Subgrade Fill	Verification of subgrade fill, including compaction equipment utilized	Visual observation	--
	Verification that Subgrade Fill containing CCRs is not placed beyond the Limit of Geosynthetic Cap System.	Visual observation	--
	Verification that unsuitable and contaminated materials are not in fill as stated in the specifications	Visual observation	--
	Lift Thickness (when prepared subgrade is fill)	Visual observation	2 foot (loose) maximum
2. Prepared Subgrade Surface	Proof-rolling.	Visual observation of the action of the compaction equipment (i.e., penetration, pumping, and cracking). Visual observation of surface condition of prepared subgrade of both cut and fill	No ruts deeper than 1 inch
	Verification that the final surface is smooth, uniform, and without large protrusions.	Visual observation of entire prepared subgrade surface	No ruts deeper than 1 inch; no protrusions greater than 3/8 inch, unless cushion geotextile used

Table 13 (Continued).

Item	Requirement	Minimum Test Frequency/Observation	Acceptance Criteria
3. Protective Cover Soil Layer	Unified Soil Classification	5H:1V slopes longer than 50 feet and 4H:1V area only: One test per acre and one test per soil type	5H:1V slopes longer than 50 feet and 4H:1V area only: CL or CH
	Maximum Particle Size	Continuous visual observation	4 inches – Test Pad may be used to demonstrate alternate acceptable particle size
	Atterberg Limits	5H:1V slopes longer than 50 feet and 4H:1V area only: One test per acre and one test per soil type	5H:1V slopes longer than 50 feet and 4H:1V area only: Plasticity Index > 15
	Field Density/Moisture Tests	5H: 1V slopes longer than 50 feet and 4H: 1V area only: Two in-place density tests per acre per lift. Minimum one test performed each day that cover is placed	5H: 1V slopes longer than 50 feet and 4H: 1V area only: 90 percent of standard proctor; +/- 3 percent OMC
	Lift thickness	Visual observation	The first lift shall be placed in a 14-inch loose lift, and the second lift sufficient to result in total compacted Protective Cover Layer thickness of 18 inches
4. Vegetative Support Layer	Maximum Particle Size	Continuous visual observation	6 inches
	Soil Fertility Testing	Vegetative Support Layer only, One test per 10 acres	Per Agronomist Recommendation
	Lift thickness	Visual observation	Compacted lift thickness of 6 inches. Total soil cover thickness 24 inches minimum

Table 13 (Continued).

Item	Requirement	Minimum Test Frequency/Observation	Acceptance Criteria
5. Structural Fill	Field Density/Moisture Tests	Four tests per acre per lift. Minimum one test performed each day that structural fill is placed	95 percent of ASTM D698 maximum dry density; +/- 3 percent OMC
	Standard Proctor Test	One test for each 40,000 cubic yards of structural fill material placed and one test for each type of material	--
	Atterberg Limits	Every time a Standard Proctor Test is performed	PI≥7
	Unified Soil Classification	Every time a Standard Proctor Test is performed	SC, ML, or CL or be existing embankment or trench material which is being replaced
	Maximum Particle Size	Visual observation	2 inches
	Lift thickness	Visual observation	12-inch loose lifts, unless indicated otherwise
6. Common Fill	Field Density/Moisture Tests	Four tests per acre per lift of common fill. Minimum one test performed each day that fill is placed	90 percent of D 698 maximum dry density; +/- 3 percent OMC
	Standard Proctor Test	One test for each 40,000 cubic yards of common fill material placed and one test for each type of material	--
	Maximum Particle Size	Continuous visual observation	12 inch
	Lift thickness	Visual observation	12-inch loose lifts
	Maximum Particle Size	Visual observation	12 inches
7. Low Permeability Soil Liner	Standard Proctor Test	One test for each 3,000 cubic yards of cover soil material placed and one test for each type of material	--
	Unified Soil Classification	One per acre and one per soil type	CH or CL or reuse existing low permeability soil liner soil or other augmented compacted clays or soils
	Atterberg Limits	One test per acre and one per soil type	--
	Combustible Content	One test per acre	--
	Visual observation	2 inches	Maximum Particle Size

Table 13 (Continued).

Item	Requirement	Minimum Test Frequency/Observation	Acceptance Criteria
7.Low Permeability Soil Liner (continued)	Field Density/Moisture Tests	Two in-place density tests per acre per 12-inch lift. Minimum three tests performed each day that low permeability soil liner is placed	At percent D 698 maximum dry density and MC determined by test pad.
	Test Pad	One per soil source	Permeability less than or equal to 1×10^{-7} cm/sec at percent D 698 maximum dry density and MC determined by test pad.
	Permeability	One per acre and one per soil type	Permeability less than or equal to 1×10^{-7} cm/sec determined by in place testing
	Lift thickness	Visual observation	8-inch lift thickness

Note:

1 Test Methods and Standards are listed in Table 12 of this CQA Plan. Sample size and location are given in the Test Standards. Corrective action if test fails is specifically listed under sections entitled "Conformance Test Failure" or generally to remove, replace or recompact until acceptance.

APPENDIX D
Surface Impoundment Closure Specifications

gai consultants

Surface Impoundment Closure Specifications
Issued for Permit

Virginia Electric and Power Company
Possum Point Power Station
Coal Combustion Residuals Surface Impoundment Closures
Dumfries, Virginia

GAI Project Number: C150132.00

November 2015

Dominion

Prepared by: GAI Consultants, Inc.
Richmond Office
4198 Cox Road, Suite 114
Glen Allen, Virginia 23060-3328

Prepared for: Dominion Resources Services, Inc.
5000 Dominion Boulevard
Glen Allen, Virginia 23060-3308

Surface Impoundment Closure Specifications Issued for Permit

Virginia Electric and Power Company
Possum Point Power Station
Coal Combustion Residuals Surface Impoundment Closures
Dumfries, Virginia

GAI Project Number: C150132.00
November 2015

11/18/2015

Dominion

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SECTION 01000
Summary of Work

Section 01000
Summary of Work

Part 1 General

1.01 Project Description

A. The Project: The Project consists of providing all labor, supervision, materials, tools, equipment, and any/all incidental services necessary for the construction of the **Possum Point Power Station Coal Combustion Residuals (CCRs) Surface Impoundment Closures.**

B. Project Location: Dumfries, Virginia (VA)

Owner: Virginia Electric and Power Company

C. Engineer Identification: The Contract Documents were prepared for the Project by:

GAI Consultants, Inc.
Richmond Office
4198 Cox Road, Suite 114
Glen Allen, VA 23060

D. Work Summary: The work to be performed under these contract documents includes, but is not necessarily limited to, the following summary, which is neither a complete or sequential listing of the work items:

1. Mobilization.
2. All submittals. (Including critical submittals that are for items that require long lead time and could delay Contract and milestone completion).
3. Limit transport of materials and construction activities as necessary to satisfy required limitations within the Eagle Nest Buffer Zones, as shown on Sheet 003.
4. Furnishing, installing, and maintaining temporary erosion and sediment control measures.
5. Locating and protecting existing utilities, structures and other facilities/property.
6. Surveying existing conditions as required and providing construction stakeout.
7. Removing existing pipes, structures, and appurtenances, as required where they exist within the work limits.
8. Clearing trees, stumps, roots, brush, and other debris within the work limits and disposing of offsite.
9. Dewatering of CCR Surface Impoundments
10. Furnishing, installing, operating, maintaining, and removing pumps and pipelines for conveying subsurface dewatered effluent and contact water from CCR Surface Impoundments A, B, C, D, and E.
11. Furnishing, installing, operating, maintaining, and removing pumps and pipelines for diverting non-contact water around Surface Impoundments A, B, C, D, and E during construction.

12. Sampling of water to ensure treatment systems meet discharge criteria.
13. Excavation and on-site (prior to October 19, 2015) or offsite disposal at a permitted facility (after October 19, 2015) of CCRs (coal combustion fly ash and bottom ash).
14. Excavating, hauling, processing, moisture conditioning, placing, compacting, and protecting earth fill and CCR material, as required.
15. Control and handling of groundwater, seeps, subsurface water, and contact water during excavation.
16. Furnish and install geotextile, drainage aggregate and perforated HDPE pipe in underdrains beneath the geosynthetic cap system as required to discharge CCR drainage during and after construction.
17. Fine grading and proof rolling to prepare subgrade surface.
18. Furnishing and installing cushion geotextile, if necessary.
19. Furnishing and installing textured 40-mil linear low density polyethylene (LLDPE) geomembrane liner.
20. Furnishing and installing geocomposite drainage net with geotextiles heat-bonded to both sides (GDN).
21. Furnish and install nonwoven filter geotextile, drainage aggregate and perforated high density polyethylene (HDPE) pipe in the subsurface drain system above the geosynthetic cap system.
22. Furnishing and installing stormwater controls, including pond embankments, riser structures, soil stormwater diversion berms, culverts, stormwater piping, inlet and outlet protection, channels, and drainage inlets. Provide and install channel linings as shown on the construction drawings.
23. Excavate, process, place, and compact protective cover soil over geosynthetic cap system without damage to geosynthetics.
24. Excavate, process, amend, and place vegetative support layer of the soil cover to remove large items and thoroughly incorporate soil amendments to produce a fully vegetated soil cover.
25. Providing positive drainage and temporary and permanent seeding of capped and disturbed areas, including borrow areas within the limits of disturbance.
26. Construct pipeline, manholes, valves, and appurtenances to convey discharge from the Power Plant's Oily Waste Pond (Internal Outfall 502) to the Plant's Low Volume Settling Ponds.
27. Sanitary Sewer Pipeline Relocation and Construction, including coordination with the Owner to schedule and perform the work with minimal impact to Station Operations.
28. Constructing perimeter and internal access roads and related guide rails and drainage features as required.
29. Quality Control System: review of submittals, surveys, observations, testing, and preparation of testing reports for geosynthetic materials.

30. Quality Control System: Coordination with the Owners Construction Quality Assurance (CQA) Team to ensure proper testing and construction of site soils, CCRs, and concrete.
31. Quality Control System: Coordination with the Owners CQA Team to ensure proper conformance testing and installation oversight of geosynthetics.
32. Prepare a Hurricane Protection Plan; Dam Breach Plan; and Spill Prevention, Control and Countermeasures (SPCC) Plan that demonstrates the Contractor's procedures and response plans in the event of a Hurricane, Dam Breach, or spill during the construction period.
33. Surveying and Record Documents (as-builts) including conformance surveys for prepared subgrade surface (Surface Impoundment D), limits of geosynthetic cap system, permanent surface and subsurface drainage structures/pipes, restored borrow areas, Phase 1 excavation grades (Surface Impoundments A, B, C, and E) and Phase 3 final grades for all Surface Impoundments including verification of the minimum 24-inch soil cover depth in Surface Impoundment D.
34. Daily maintenance of roads used during construction.
35. Daily dust control.
36. Maintaining and submitting acceptable Contractor's Daily Construction Reports as required herein.
37. Stormwater basins cleanup and sediment (unsuitable material) offsite disposal after project completion.
38. Site cleanup.
39. Post Construction Maintenance.
40. Demobilization.

1.02 Work Sequence

A. Contractor shall be solely responsible for coordination of all the work to meet the requirements of the Contract Documents for all Phases of work within each Surface Impoundment.

B. The Contractor is responsible for scheduling and sequencing the work to complete the work within the timeframe, milestones, substantial completion, and final completion dates required by the Contract Documents.

C. Prior to Notice to Proceed, the Contractor is responsible for submitting a construction activities schedule to be approved by the Owner's Representative. Contractor shall phase water treatment, dewatering, excavation, fill, geosynthetic cap system construction, soil cover construction, stormwater management system, and placement of piping and other features as required in these Contract Documents in a logical and efficient order.

D. The work shall minimize moving, hauling, and stockpiling of materials, avoid the deployment, placement, and welding of geosynthetic materials during periods of inclement weather, provide protection of geosynthetic and soil material during and after placement and testing, and minimize the need for rework or re-testing of elements that have been previously completed but have not been properly protected.

E. The work shall be completed according to the Phasing plans shown on the construction drawings. The Contractor may submit a plan for approval by the Owner's Representative to further subdivide the proposed phasing or proposed a different phasing plan to complete the work.

1.03 Interpretation of the Contract Documents

A. The Owner's Engineer is responsible for interpreting the Contract Documents. The Owner's Engineer interpretation shall be consistent with the intent that can be reasonably inferred from the Contract Documents, in their entirety. In case of conflicts within the Contract Documents or between the Contract Documents and other referenced standards or specifications, the Contractor shall notify the Owner's Representative immediately and any necessary changes shall be adjusted as provided in the contract for changes in the work. If the Contractor performs any work knowing such differences occur, or that the work is contrary to any laws, ordinances, rules and regulations, and without such notice to the Owner's Representative, he shall bear all cost arising there from.

B. Reference to Standard Specifications: Reference to standard specifications such as ASTM International, American Nation Standards Institute, American Water Well Association, etc., shall be the specification in effect at the date of advertisement unless otherwise stated.

C. Intent of Drawings:

1. The drawings are intended to show general features and locations of piping, equipment, fixtures and specialties, and do not necessarily show all required offsets and details. All work shall be accurately laid out with reference to the drawings and in cooperation with other trades to avoid conflicts and to obtain a neat and workmanlike installation.

2. The drawings are not intended to be rigid in specific details and where they may be in conflict with requirements of the other drawings, or of any applicable code or ordinance, or with recommendations of the manufacturers of any equipment actually furnished, installed or connected, the work hereunder includes the making of such adjustments as may be required to cause all such equipment to be installed and connected in conformance with such codes, ordinances or recommendations for the safe, proper and efficient operation of the equipment as approved by Owner's Engineer.

1.04 General Paragraphs

A. Tools, Plant, and Equipment: If at any time before the commencement or during the progress of the work, tools, plant or equipment appear to the Owner to be insufficient, inefficient, or inappropriate to secure the quality of the work required or the proper rate of progress, the Owner may order the Contractor to increase their efficiency, to improve their character, to augment their number or to substitute new tools, plant, or equipment as the case may be, and the Contractor must conform to such order, but the failure of the Owner to demand such an increase of efficiency, number or improvement shall not relieve the Contractor of his obligation to secure the quality of work and the rate of progress necessary to complete the work within the time allowed and to the satisfaction of the Owner.

B. Maintenance of Service, Prior Use by Owner: All existing utilities, both public and private, including sewer, gas, water, electrical services, etc., shall be protected and their operation shall be maintained throughout the course of the work. Any temporary shutdown of an existing service shall be arranged between the Contractor and the responsible agency. The

Contractor shall assume full responsibility and hold the Owner harmless from the result of any damage that may occur as a result of the Contractor's activities. Prior to completion of the work, the Owner (by agreement with the Contractor) may take over the operation and/or use of the completed project or portions thereof. Such prior use of facilities by the Owner shall not be deemed as acceptance of any work or relieve the Contractor from any of the requirements of the Contract Documents.

C. Codes, Laws, and Regulations:

1. It is intended that all work to be performed be in compliance with the latest editions of all applicable federal, state, and local codes, laws and regulations governing standards of design, construction workmanship, materials, types of equipment, and methods of installation in Prince William County, VA. If the Contractor performs any work knowing it to be contrary to such laws, ordinances, rules and regulations, and without such notice to the Owner's Representative, he shall bear all cost arising therefrom.
2. It shall be the Contractor's responsibility to comply with the Erosion and Sediment Control Plan for the Project and to otherwise comply with the Erosion and Sediment Control Law.

D. Safety and Health Requirements:

1. The Contractor shall comply with the Department of Labor's Safety and Health Requirements for construction promulgated under the Occupational Safety and Health Act of 1970 (PL 91-596) and under Section 107 of the Contract Work Hours and Safety Standards Act (PL 91-54) and all amendatory requirements thereof.
2. The Contractor shall comply with all Owner's health and safety and accident reporting requirements as stated in the Dominion Contract.

Part 2 Products

Not used.

Part 3 Execution

Not used.

-End of Section-

SECTION 01350
Submittals

Section 01350
Submittals

Part 1 General

1.01 General Paragraphs

A. Contractor shall submit for the approval of the Owner's Representative, prior to start of construction, details or shop drawings, and manufacturer's specifications of all materials and equipment he intends to furnish under or as part of this project.

B. All submittals shall be provided in digital format such as Adobe Acrobat (PDF) or other approved program and electronically sent the Owner's Representative; a hard copy of each submittal shall be received by the Owner's Representative within 5 days of the digital version.

C. Equipment shall not be fabricated, ordered, or delivered until submittals and shop drawings have been approved.

D. No portion of the work requiring submission of shop drawings, product data, or sample shall commence until the submittal has been approved by the Owner's Representative. All such portions of the work shall be in accordance with approved submittals.

E. For substances that are proposed for use in the project that may be hazardous to human health, the Contractor shall submit to the Owner's Representative, for information only, information on precautions for safety using these substances, including Manufacturer's Safety Data Sheets (MSDS's), certification of registration by the Contractor with authorities under the respective Virginia and Federal Toxic Substances Control Acts.

F. All deliveries shall be accompanied with a ticket or manifest indicating the origin of the shipment, the name of the manufacturer and supplier, a detailed description of the material/item(s) delivered, and the quantity of material/items delivered.

G. Submit all delivery tickets within 48 hours of delivery or at least 48 hours before actual use of the material/item(s), whichever occurs first.

H. Contractor shall submit to the Owner's Representative for approval, at least 21 days before procurement, a Certificate of Compliance from the manufacturer that the supplied materials or equipment meet the specifications.

I. Shop drawings shall be accompanied with a certificate, signed by Supplier and Contractor, stating that products comply with the requirements of the relevant Specifications.

J. Provide a separate submittal for each product specified herein. Do not combine multiple products in a single submittal, unless approved specifically by the Owner's Representative.

K. Each Submittal shall contain only information relevant to the section and/or requirement for which the submittal is made. Extraneous information and literature shall be removed.

L. When submitting manufacturer's information or catalog cuts, highlight the particular product for which the submittal is made using arrows, color, and underlining, to make the submittal clear.

M. Each submittal shall be accompanied by a cover sheet which contains the following information:

1. Project Name.
2. Contractor's name.
3. Supplier.
4. Material submitted.
5. Applicable Specifications Section(s).
6. Applicable Plan Sheet(s).
7. Date of Submittal.
8. Submittal Number.
9. Identify whether submittal is a new submittal or re-submittal.
10. Statement and signature indicating relevance and approval by the Contractor.

N. The Contractor shall utilize a 10 character submittal identification numbering system for all material and equipment submittals including drawings, cut sheets, and manufacturer's information in the following manner:

1. The first character shall be an S.
2. The next five digits shall be the applicable specification section number.
3. The next three digits shall be the numbers 001 – 999 to sequentially number each separate item or drawing submitted under each specific section number.
4. The last character shall be a letter, A-Z, indicating the submission or resubmission of the same drawing, e.g., A = first submission, B = second submission, C = third submission, etc. A typical submittal number would be as follows:

S-02200-008-B

S	Submittal
02200	Specification Section for Earthwork
008	The eighth different submittal under this specification
B	The second submission (1st resubmission) of that particular submittal

O. The Contractor shall direct specific attention, in writing, or on resubmitted shop drawings, product data, or samples, to revisions other than those requested by the Owner's Representative on previous submittals.

P. The cover sheet for each shop drawing submittal shall contain a blank space, at least 4" square, for the Owner's Representative approval.

Q. The Contractor's Responsible Party shall coordinate, review, and approve all submittals prior to submission to Owner's Representative.

R. Approval of the Contractor's shop drawings will be general and shall not relieve the Contractor from the responsibility for adherences to the Contract Document, nor shall it relieve him of the responsibility for any errors, which originated with the submittal. Where such errors or omissions are discovered later, they shall be corrected by the Contractor at no additional cost, irrespective of any approval by the Owner's Representative or Owner's Engineer.

S. Owner's Representative / Owner's Engineer review time shall be as follows:

Material and sample submittals: 7 days
Shop drawings: 10 days
Record documents: 10 days
Test results: 10 days
Schedules: 10 days
Conformance Surveys: 10 days
Request for Information/Clarification: 10 days

T. Submit a Record (Log) of Submittals, to the Owner's Representative prior to construction and an updated log before each progress meeting. The Submittal Log shall include all submittals anticipated for the Work, based on the Contract Documents, in their entirety.

U. All items, information, requests, and documents transmitted by the Contractor to the Owner's Representative shall be considered submittals and shall be submitted in accordance with this section.

Part 2 Products

Not used.

Part 3 Execution

Not used.

-End of Section-

SECTION 01400
Construction Requirement
Services and Temporary Facilities

Section 01400
Construction Requirement Services and Temporary Facilities

Part 1 General

1.01 Summary

The requirements of this Section apply to, and are a component of, each section of the specifications. The Contractor is responsible for furnishing all labor, equipment, materials, and provisions to provide temporary facilities and controls, including but not limited to the Owner Representative's/Owner Engineer's/Construction Quality Assurance (CQA) Consultant's and Contractor's field offices, Contractor's storage area(s), utility connections/hookups and permits for water service, electrical service, telephone service, maintenance of traffic, barricades, fences, damage to existing property, security, access roads, drainage, parking, and emergencies.

1.02 Office Facilities

A. Contractor shall provide and maintain a field office trailer for his onsite staff where shown on the Plans.

B. Contractor shall provide and maintain a second temporary field office for the use of Owner's Representative, the Owner Engineer, and the Owner's QC Team.

C. Contractor shall be responsible for obtaining all necessary permits for the trailers.

D. Contractor shall provide his onsite Superintendent and his Project Manager with functional cellular telephones and email devices with access to the devices 24 hours per day, 7 days per week, including weekends and holidays.

E. Copies of the Plans, Specifications, and other Contract Documents shall be kept at Contractor's office at the site of the work and available for use by the Contractor's employees and his subcontractors at all times.

F. At a minimum, one copy of the Standard Handbooks and Specifications listed below shall be provided by the Contractor kept in the Owner/Engineer's office trailer for onsite use by all parties:

   1. Virginia (VA) Erosion and Sediment Control Handbook; current edition as of Bid Advertisement Date.
   2. VA Department of Transportation Road and Bridge Standards; current edition as of Bid Advertisement Date.
   3. VA Department of Transportation Road and Bridge Specifications; current edition as of Bid Advertisement Date.
   4. Prince William County's Design and Construction Standards Manual; current edition as of Bid Advertisement Date.

G. Maintenance and Equipment. The Contractor shall provide the following for his trailer and the Owner's Representative's Trailer:

   1. Provide janitorial, cleaning, removal of waste, security services, and supplies once per week for the duration of the project.
   2. Drinking Water.

3. Copy Machine.
4. Electric power, lights, heating and cooling.
5. Three desks, three desk chairs, three side chairs, plan review table, large conference table and 15 chairs (for meetings).

H. In the event the field office or appurtenant facilities are damaged or destroyed during the contract period due to Contractor's actions or negligence, the Contractor shall, at his expense, repair or replace the same to its original, like new condition.

I. Contractor shall be responsible for all equipment in the office trailers, and shall make good, or replace in kind, at his own expense, any such equipment damaged or lost through fire, theft, and/or vandalism for the duration of this Contract.

J. Contractor shall maintain the existing parking area outside the office trailers in good condition.

1.03 Temporary Utilities

A. Electric Power:

1. Contractor shall supply Class II emission portable electric generators of sufficient size to power the office trailers.
2. Temporary electric power installations shall meet construction safety requirements of Dominion, Occupational Safety, and Health Administration, state, and other governing agencies.
3. An electric pole with service feed is available in the Pond D Laydown Area.
4. Cost of fuel for generators for electric power used during performance of the work shall be borne by the Contractor.

B. Internet Access: Install broadband internet modem at the Owner's Representative office and coordinate with the internet service provider to connect and provide broadband internet service. Contractor shall pay any installation fees of establishing the Owner's Representative internet service and all fees associated with the internet service for the duration of the Contract.

C. Water: Contractor is responsible for coordinating with water utility and obtaining water hookup and required permit for connection to nearby hydrant. Cost of water shall be paid for by Contractor.

1.04 Removal of Temporary Construction

A. Remove temporary materials, equipment, services, and construction prior to final inspection.

B. Clean and repair damage caused by installation or use of temporary facilities. Remove underground installations to a depth of 2 feet, grade site as required. Restore existing facilities used during construction to specified or original condition.

C. Remove erosion and sediment controls at the direction of the Erosion and Sediment Control Inspector.

Part 2 Products

Not used.

Part 3 Execution

Not used.

-End of Section-

SECTION 01450
Dust Control and Air Compliance

Section 01450
Dust Control and Air Compliance

Part 1 General

1.01 Description of Work

A. The Contractor shall employ construction methods and means that keep airborne particulates to the minimum and shall provide for the application of water or employ other appropriate preventive means or methods to maintain dust control, subject to the approval of the Owner.

B. Dust control measures shall be compatible with existing on-site materials and proposed materials.

C. The contractor shall comply with the Owner's air Permit Requirements.

1.02 Related Sections

A. Site Preparation - 02100

B. Earthwork - 02200

C. Site Clearing and Grubbing - 02110

1.03 General Description of Air Permit Requirements

A. Standards for Non-Road Engines:

Non-Road Engines are exempt from permitting. Contractor shall provide list of all engines for evaluation prior to mobilizing equipment onsite. Contractor shall track the time each Non-Road Engine arrives on site and is removed from the site and provide this information to the Owner's Representative on a weekly basis.

To qualify as a Non-Road Engines all of the following shall be met:

- Engine that is used in or on a piece of equipment that is self-propelled or serves a dual purpose by both propelling itself and performing another function (such as a garden tractor, off-road mobile cranes and bulldozers).
- Engine that is used in or on a piece of equipment that is intended to be propelled while performing its function (such as lawnmowers and string trimmers).
- By itself or in or on a piece of equipment it is portable or transportable, meaning designed to be and capable of being carried or moved from one location to another. Included but not limited to wheels, skids, carrying handles, dolly, trailer, or platform.

An internal combustion engine is not a non-road engine if it remains or will remain at a location for more than 12 consecutive months. Any engine or engines that replaces an engine at a location that are intended to perform the same or similar function as the engine replaced will be included in calculating the consecutive time period for the 12 month time requirement.

B. Internal combustion engines that are not non-road engines (stationary engines):

- If the engine holds a permit, the Contractor shall provide information so that the Owner may notify the VA DEQ 15-days before the engine arrives on site.

- As applicable, Contractor shall provide the Owner with documentation that the engines comply with the requirements of MACT ZZZZ, NSPS IIII, or NSPS JJJJ. The Owner will evaluate and approve documentation to make sure the engine meets the requirements of Station's air permit.

C. All air emitting equipment should be reported to Dominion's environmental group for air permitting evaluations.

D. Fuel Standards for Non-Road Engines:

- Fuel for non-road diesel engines must have a sulfur content less than or equal to 15 parts per million (Ultra Low Sulfur fuel).
- The storage tanks (including dispensers) containing the Ultra-Low Sulfur fuel must be properly labeled and permitted and installed according to the applicable SPCC requirements.

E. Vehicle Idling Restrictions VA Requirement:

- Licensed on-road motor vehicles restricted to no more than 3 minutes when parked in urban areas.
- Exception for necessity to provide auxiliary power (i.e., a bucket truck's lift).
- May not idle to provide heating or air conditioning.

F. Fugitive Dust (9 VAC 5-50-90):

- During the operation of a stationary source or any other building, structure, facility, or installation, do not permit any materials or property to be handled, transported, repaired, or demolished without taking reasonable precautions to prevent fugitive emissions (dust) from becoming airborne.
- Use water to control dust. Examples include the demolition of structures, construction operations, stockpiles, dewatered CCR, grading of roads or clearing of land.
- Stabilize or apply water on dirt roads, materials stockpiles and other surfaces which may create airborne dust.
- Pave roadways as needed, and maintain them in a clean condition.
- Adequate containment methods should be employed during sandblasting or similar operations.
- Open equipment for conveying or transporting material likely to create objectionable dust shall be covered or treated in an equally effective manner at all times when in motion.
- Promptly remove spilled or tracked dirt or other materials from paved streets. This also includes the removal of dried sediments resulting from soil erosion.
- Chemicals may be proposed for dust control if water is not effective. Any chemical proposed for use for dust control must be approved by the Owner's Representative prior to use.

Part 2 Products

Not used.

Part 3 Execution

3.01 Dust Control

A. During grading activities, soils and CCRs will be treated using wet suppression for dust control. Watering equipment shall be used to minimize airborne concentrations and shall consist of pipelines, tank trucks, or other devices approved by the Owner, which are capable of applying a uniform spread of water over the ground surface. A suitable device for a positive shut-off and for regulating the flow rate of water shall be located so as to permit positive operator control. Calcium chloride is not allowed for dust control.

B. Minimize the exposed area of disturbed material.

C. Depending on the expected weather conditions, exposed disturbed material may only be left exposed over night after wet suppression treatment and sealing with smooth drum roller.

D. Stabilize exposed subgrade with wet suppression treatment and sealing with smooth drum roller if liner system is not installed in the same day.

E. Site activities may be suspended if sustained wind speeds exceed 25 miles per hour or during adverse weather conditions.

-End of Section-

SECTION 01500
Project Record Documents

Section 01500
Project Record Documents

Part 1 General

1.01 Summary

A. The purpose of the final Record Documents is to provide factual information regarding all aspects of the Work, both concealed and visible, to enable future modification of the design to proceed without lengthy and expensive site measure, investigation, and examination.

B. The Contractor shall maintain at the site for the Owner's and Owner's Representative's permanent records two complete set of Record Documents which include a copy of the Contract Drawings, Contract Specifications, Addenda, Change Orders, Owner Field Orders, Shop Drawings, Quality Control Field Reports, Product Data, and Samples. The Contract Plans are to be used as Record Drawings by the Contractor.

C. Submit three bound sets of Record Drawings to the Owner's Representative upon completion of the project. Employ the services of a licensed surveyor, licensed in the Commonwealth of VA, to prepare and seal the Record Drawings.

D. The following record drawings shall be provided by the Contractor's Independent Surveyor.

1. Existing conditions prior to starting contract work (Contractor may supplement and verify existing topographic mapping).
2. Survey of Ash Placement in Surface Impoundment D after completion of Dredging A, B, C, and E.
3. Phase 1 Grading – Surface Impoundments A, B, C, and E.
4. Sanitary Sewer Relocation – Surface Impoundments A, B, and C.
5. Phase 2 Grading – Surface Impoundments A, B, C, D, and E.
6. Limit and thickness verification of existing constructed or natural Low Permeability Soil in Surface Impoundment D.
7. Limit of GCL installation in Surface Impoundment D.
8. Prepared Subgrade Surface – Surface Impoundment D.
9. Underdrain Piping, Alignments, and Inverts – Surface Impoundment D.
10. Temporary Sediment Ponds, Surface Impoundments B, C, and E - Principal Spillway Riser Crest, Barrel Inlet Invert Elev., Barrel Outlet Invert Elev., Emergency Spillway Crest, and Limit of Outlet Protection.
11. Limit of Geosynthetic Cap System – Surface Impoundment D.
12. LLDPE geomembrane panel layout and repair locations.
13. Phase 3 Grading (Final Grades) – Surface Impoundments A, B, C, D, and E. Include:
    - Grading
    - Channel Cross Sections

- Channel Profiles
- Limit of Channel Lining Protection (Rip-Rap, Cellular Concrete Mattresses, Gabions, etc.)
- Thickness verification for final cover system in Surface Impoundment D

14. Subsurface Drainage Piping Alignments, Inverts, Outlets, and Cleanout Locations – Surface Impoundment D.
15. Piezometer and Vent Locations - Surface Impoundment D.
16. Final Grading - Borrow Areas.
17. Access Roads - Limits, Drainage Pipe/Culvert Inlet and Outlet Invert Locations and Elevations.
18. Plugged/Grouted Existing Pipes.
19. Fencing

1.02 Submittals

A. At Contract closeout, submit Record Documents to Owner's Representative for the Owner.

B. Accompany submittal with transmittal letter in duplicate, containing:

1. Date
2. Project title and number
3. Contractor's name and address.
4. Title and number of each Record Document.
5. Signature of Contractor or his authorized representative.

Part 2 Products

2.01 Record Drawings

A. Record Prints: Maintain one set of blue or black-line white prints of the Drawings and Shop Drawings.

1. Preparation: Mark Record Prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to prepare the marked-up Record Prints.
   a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
   b. Accurately record information in an understandable drawing technique. Record data on Drawing or log book as soon as possible after obtaining. Record and check the markup before enclosing concealed installations.
2. Content: Types of items requiring marking include, but are not limited to, the following:
   a. Dimensional changes to Drawings.
   b. Revisions to details shown on Drawings.

c. Locations and depths of underground utilities.

d. Revisions to routing of piping and conduits.

e. Details not on the original Drawings.

f. Field records for variable and concealed conditions.

3. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at the same location.

4. Mark important additional information that was either shown schematically or omitted from original Drawings.

B. Record Drawings: Immediately before inspection for Certificate of Substantial Completion, review marked-up Record Prints with Owner's Representative. When authorized, prepare a full set of corrected prints of the Contract Drawings.

1. Incorporate changes and additional information previously marked on Record Prints. Erase, redraw, and add details and notations where applicable.

C. Format: Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.

Part 3 Execution

3.01 Recording and Maintenance

A. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and modifications to Project Record Documents as they occur; do not wait until the end of Project.

-End of Section-

SECTION 02100
Site Preparation

Section 02100
Site Preparation

Part 1 General

1.01 Description of Work

A. The Contractor shall furnish all materials, labor, equipment, tools, and appurtenances required to complete the work.

B. Comply with applicable codes, ordinances, rules, regulations and laws of local, municipal, state, or federal authorities having jurisdiction.

C. Remove and dispose of all debris, bulky items, waste materials, etc. existing in the area to be constructed and encountered on the surface. All bulky items such as large debris, stumps, cars, old fencing, etc. are to be disposed off-site at Contractor's expense.

D. Protect and maintain bench marks, monuments and other reference points. Re-establish, at no cost to the Owner, any such reference points if disturbed or destroyed. The Contractor's surveyor shall conduct a survey of all monuments and property markers within proposed cover areas prior to any disturbance such as they can be re-established after completion of the cover by the Contractor as part of this Contract.

E. Remove, demolish, excavate, haul, and dispose of any on-site structures, pavement, roads, drainage pipes, utilities, etc. per Part 1.01C. above as shown on the Contract Drawings. Removal of on-site facilities shall be approved by the Owner's Representative prior to the work.

1.02 Related Sections

A. Site Clearing and Grubbing - 02110

B. Earthwork – 02200

Part 2 Products

Not used.

Part 3 Execution

Not used.

-End of Section-

SECTION 02110
Site Clearing and Grubbing

Section 02110
Site Clearing and Grubbing

Part 1 General

1.01 Description of Work

A. The Contractor shall furnish all materials, labor, equipment, tools and appurtenances required to complete the work as described below. Contractor shall implement and supervise all work.

B. Site clearing includes, but is not limited to, removing from the limits of work and disposing of trees, stumps, roots, brush, structures (at and below ground) including concrete riser and walkway, abandoned utilities, trash, asphalt, debris and all other materials found on or near the surface of the ground in the construction area. Precautionary measures that prevent damage to existing features to remain are part of the work.

C. Comply with applicable codes, ordinances, rules, regulations and laws of local, municipal, state, or federal authorities having jurisdiction.

D. No clearing and grubbing will be allowed without adequate erosion and sedimentation control measures in place and to the satisfaction of the Owner or Owner's Representative.

1.02 Related Sections

A. Erosion and Sediment Control - 02125

B. Earthwork - 02200

1.03 Job Conditions

Location of the Work: The area to be cleared and grubbed includes all areas designated for cap construction, access road construction, channel construction, and required construction access areas.

Part 2 Products

The Contractor shall furnish equipment of the type normally used in clearing and grubbing operations including, but not limited to, dozers, shears, skidders, loaders, root rakes, chipping equipment and stump grinders.

Part 3 Execution

3.01 Scheduling of Clearing

A. Contractor shall install all temporary Soil Erosion and Sedimentation Control Structures per Contractor's plan to the acceptance of Owner and Owner's Representative prior to start of clearing operations.

B. Contractor shall maintain all survey controls.

3.02 Construction Area Clearing and Grubbing

A. Materials to be cleared, grubbed, and removed from the construction areas include, but are not limited to, the following: all trees, stumps, roots, brush, trash, organic matter i.e. logs, root balls, etc., miscellaneous structures, debris, and abandoned utilities.

B. Grubbing shall consist of completely removing roots, stumps, trash and other debris from all graded areas so that surface material is free of roots and debris. Surface material is to be left sufficiently clean so that further picking and raking will not be required.

C. All stumps, roots, foundations, and debris embedded in the ground shall be removed and disposed.

D. All construction areas shall be grubbed by tractors with root rakes.

E. Where tree limbs interfere with utility wires, or where the trees to be felled are in close proximity to utility wires, the tree shall be taken down in sections to eliminate the possibility of damage to the utility. The Contractor shall be responsible for damages to utilities and shall replace/repair damaged utilities at no cost to Owner.

F. Any work pertaining to utility poles and guy wires shall comply with the requirements of the appropriate utility.

G. Stumps and roots shall be grubbed and removed to a depth of 18 inches below original grade. All holes or cavities which extend below the subgrade elevation of the proposed work shall be filled with crushed rock not larger than No. 57 aggregate or other suitable material, and compacted to a similar density as the surrounding material.

H. The Contractor shall exercise special precautions for the protection and preservation of identified trees and shrubs with the construction area or those situated adjacent to the limits of the construction area. The Contractor shall be held liable for any damage the Contractor's operations have inflicted on such property.

I. The Contractor shall be responsible for all damages to existing structures and/or improvements resulting from Contractor's operations.

3.03 Disposal of Debris

A. All wood debris (stumps, roots, branches, and leaves) resulting from the clearing and grubbing operation shall be disposed of offsite or by other methods as approved by Owner's Representative, in accordance with the Drawings and Specifications.

B. All large debris, pipe, large metal objects, and bulky items will be removed and hauled to an off-site approved disposal facility.

-End of Section-

SECTION 02125
Erosion and Sediment Control

Section 02125
Erosion and Sedimentation Control

Part 1 General

1.01 Description of Work

A. The work shown on the Contract Drawings and Prince William County Approved Site Plan for the Project shall be considered a minimum requirement. What is shown shall not relieve the Contractor of the responsibility to actively take all steps necessary to control soil erosion and sedimentation control.

B. The Contractor shall provide all materials and promptly take all actions necessary to achieve effective erosion and sedimentation control in accordance with all applicable federal, state, and local enforcing agency guidelines and these Specifications. Contractor shall provide a Certified Responsible Land Disturber (RLD) to implement and supervise all work.

C. Comply with applicable codes, ordinances, rules, regulations and laws of Prince William County, and Commonwealth of Virginia.

D. Contractor shall repair any material or existing surface conditions damaged by erosion or covered with sedimentation at the Contractor's expense.

E. Contractor shall maintain at least 20 percent overstock of erosion control items stockpiled on-site for ease of use to replace installed items as deemed necessary, or provide evidence that necessary amounts of materials are readily available from local suppliers.

F. The temporary erosion control features installed by the Contractor shall be maintained by the Contractor until no longer needed as determined by the Owner, or permanent erosion control methods are installed.

G. It shall be the sole responsibility of the Contractor to properly schedule and coordinate all necessary labor, equipment, and materials such that the specified work is performed in accordance with the project schedule and the Contract requirements. At the discretion of the Owner, the Owner may reject or direct the Contractor to repair (at no cost to the Owner) those items which are detrimental to the project or not in compliance with the Contract Documents. Such direction or rejection by the Owner shall not relieve the Contractor of his obligation to properly schedule and perform other specified work items in conformance with the Contract Documents.

1.02 Related Sections

A. Site Clearing and Grubbing - 02110

B. Earthwork - 02200

C. Drain Gravel/Coarse Aggregate - 02233

D. Stone Riprap - 02271

E. Geotextile - 02595

F. Seeding - 02936

1.03 References

A. Virginia Erosion and Sediment Control Handbook (VESCH), Third Edition, 1992.

1.04 Submittals

Submit product submittals for all erosion and sediment control products to be utilized at the site, upon request by the Owner's Representative.

The Contractor shall submit the manufacturer's product data, the installation manual, and maintenance information for erosion and sediment control geosynthetics.

Part 2 Products

Install the products in the locations shown on the plans and in accordance with requirements of Prince William County and the VESCH manual.

2.01 Silt Fence and Super Silt Fence

Silt fence shall be in accordance with the VESCH and Prince William County Requirements.

2.02 Bales

Silt fence shall be in accordance with the VESCH and Prince William County Requirements.

2.03 Seed

Seed type shall meet the requirements the VESCH and Section 02936 - Seeding.

2.04 Temporary Erosion Control Mat/Blanket

Temporary Erosion Control Mat/Blanket shall meet the requirements of EC-2 matting and be in accordance with the VESCH and Prince William County Requirements.

2.05 Permanent Erosion Control Mat/Blanket

Permanent Erosion Control Mat/Blanket shall meet the requirements of EC-3 matting and be in accordance with the VESCH and Prince William County Requirements.

Permanent Erosion Control Mat/Blanket EC-3 matting shall be Tensar/North American Green Vmax® P550® Turf Reinforcement Mat (TRM) or approved equal, and Tensar/North American Green Vmax® SC250® TRM or approved equal.

2.06 Sediment Filter Bags

Sediment Bags shall be in accordance with the VESCH and Prince William County Requirements.

2.07 Sediment Traps

Sediment Traps shall be in accordance with the VESCH and Prince William County Requirements.

2.08 Rock Check Dams

Rock Check Dams shall be in accordance with the VESCH and Prince William County Requirements.

2.09 Temporary Sediment Basins and Risers

Temporary Sediment basins and their apparatuses shall be in accordance with the VESCH and Prince William County Requirements.

Part 3 Execution

Refer to the Project's Prince William County Site Plan for Erosion and Sediment Control Requirements and Specifications.

The Contractor shall install E-3 matting in accordance with the manufacturer's installation manual.

The extent of Erosion and Sediment Control materials and methods shall be as shown on drawings.

-End of Section-

SECTION 02150
Construction Dewatering

Section 02150
Construction Dewatering

Part 1 General

1.01 Description of Work

A. This section specifies the requirements for handling and management of dewatering activities.

B. Contractor shall dewater existing Surface Impoundment D using rim ditches, well point systems, or other means approved by the Owner's Representative. Dewatering shall be completed for the duration of the project until the top 10 feet of CCR below the proposed subgrade elevation is dry or the CCR is sufficiently dewatered to allow for the installation of the geosynthetic cap. Active Dewatering using well points and Rim Ditches shall continue until the geosynthetic cap system is installed. Subsurface dewatered water and CCR contact water shall be pumped to the sanitary sewer or water treatment system to be installed in Surface Impoundment E, in accordance with the Owner's VPDES Permit VA0002071. Well points shall be cut off at a minimum of 5-feet below the geosynthetics liner and the pipe covered with regraded soil or CCR materials. If approved or requested by the owner' representative, select well points or dewatering wells may be booted through the geosynthetic cap system for continued dewatering and/or water level monitoring after the final cover system construction.

C. The Contractor may install underdrains beneath the cap system as required to dewater the CCR during the construction process. Subsurface dewatering water, which is collected by any underdrain systems, shall be pumped to the water treatment system to be installed in Surface Impoundment E. After the geosynthetic cap system is installed, the underdrains may continue to operate as a passive dewatering system. Once the underdrains have dried up due to the sufficient dewatering of the CCR in the surface impoundment, the underdrains may be capped in place.

D. Contractor shall design, construct, and maintain all dikes, sumps, and diversion and drainage channels as necessary to complete the construction and to protect the areas to be occupied by permanent work from water damage and divert non-contact water around the work area to the extent possible. Contractor shall remove temporary works after they have served their purpose.

E. Contractor shall be responsible for the stability of all temporary and permanent slopes, grades, foundations, materials and structures during the course of the Contract. Repair and replace all slopes, grades, foundations, materials and structures damaged by water, both surface and subsurface, to the lines, grades, and conditions existing prior to the damage, at no additional cost to Owner.

F. Contractor shall implement and supervise all Work.

G. The Contractor shall submit a description of its methods for accomplishing construction dewatering to Owner and Owner's Representative for approval (Construction Dewatering Plan).

H. Contractor shall provide measures to minimize accumulation of surface water in the work area.

1.02 Related Sections

A. Erosion and Sediment Control - 02125

B. Earthwork - 02200

Part 2 Products

Piping, pumping equipment, and all other equipment and materials required for dewatering shall be suitable for the intended purpose. Standby pumping units shall be maintained at the Site to be used in case of failure of the normal pumping units.

Part 3 Execution

3.01 Dewatering

A. Design, furnish, install, maintain, monitor, operate, and remove necessary pumping and other equipment for dewatering the CCR surface impoundments and other parts of the Work and for maintaining the work areas free from water as required for constructing each part of Work.

B. Install Dewatering System at surface impoundments A, B, C and E as required to dewater the CCR for removal of CCR from the impoundments. Install Dewatering System at Surface Impoundment D to dewater a minimum of the top 10 feet of CCR to create a stable workable CCR surface that can be graded, compacted, and capped with soil fill and geosynthetics.

C. Furnish, install, operate, and maintain pumps and pipelines for conveying subsurface dewatering effluent and contact water from CCR Surface Impoundment A, B, C, and E to Pond D, the sanitary sewer, or a water treatment system in CCR Surface Impoundment E area.

D. Furnish, install, operate, and maintain pumps and pipelines for diverting non-contact stormwater around CCR Surface Impoundments A, B, C, D and E during construction.

E. Dewater by means which will enable completion of the Work and preserve final lines and grades. Do not disturb or displace adjacent soil.

F. All pumping and drainage shall be done with no damage to property or structures and without interference with the rights of the public, owners of private property, pedestrians, vehicular traffic or the Work of other Contractors, and in accordance with all Federal, State, and local laws, ordinances and regulations.

G. Do not overload or obstruct existing drainage facilities.

H. After they have served their purpose, remove all temporary protective work at a time and in a manner approved by the Owner. All temporary diversion channels and other temporary excavations shall be cleaned out, backfilled and processed under the same specifications as those governing earthwork (Subgrade Fill and Soil Cover Layers).

I. When the temporary works will not adversely affect any item of permanent work on the planned usage of the project, Contractor may be permitted to leave such temporary works in place. In such instances, breaching of dikes and other temporary works may be required.

J. Pump all dewatering effluent and diverted surface water to the appropriate outfall or treatment system as directed by the Owner's Representative.

K. By the use of pumps, siphons, tile drains or other approved methods, Contractor shall control the flow and accumulation of water in excavated areas to prevent excessive softening and disturbance of exposed soils in excavations as necessary for completion of the Work. The system used shall not cause settlement damage to adjacent structures. The Contractor shall carry out the Work by the use of other methods which will not endanger adjacent structures; all such Work shall be done at the no expense to the Owner.

-End of Section-

SECTION 02200
Earthwork

Section 02200
Earthwork

Part 1 General

1.01 Description of Work

This section includes technical requirements for excavation, as well as construction of the earthworks including Soil Cover Layers.

1.02 Related Work Specified Elsewhere

A. Seeding - 02936

B. Linear Low Density Polyethylene Geomembrane - 02597

C. Geotextiles - 02595

D. Geocomposite Drainage Net - 02590

E. Erosion and Sediment Control - 02125

F. Geosynthetic Clay Liner - 02598

1.03 Submittals

A. Prior to the start of work, the Contractor shall submit a list of equipment to be used for fill placement and proof-rolling operations to the Owner's Representative for review and approval.

1.04 References

The following codes and standards are referenced in this Section:

A. ASTM International (ASTM) Standards:

1. ASTM C136, "Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates."
2. ASTM D422, "Standard Test Method for Particle-Size Analysis of Soils."
3. ASTM D698, "Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort."
4. ASTM D2216, "Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass."
5. ASTM D2487, "Classification of Soils for Engineering Purposes (Unified Soil Classification System)".6.ASTM D2488, "Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)."
6. ASTM D2937, "Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method."
7. ASTM D4318, "Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils."
8. ASTM D5084, "Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Material Using a Flexible Wall Permeameter."
9. ASTM D6938, "Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)."

B. Geosynthetic Research Institute (GRI):

1. Guide GS11, "Standard Guide for Constructing Test Pads to Assess Protection Materials Intended to Avoid Geomembrane Puncture."

Part 2 Products

2.01 Material

2.01.1 Unsuitable Material

Unsuitable material for any earthwork shall be defined as ice, frozen material, liquids, organic matter, organic soil (peat), rubbish, litter, debris, rubble, wood, stumps, brush, root mass, leaves, metal, or trash. Unsuitable Material identified by the Contractor shall be approved by the Owner's Representative.

2.01.2 Coal Combustion Residuals (CCRs)

A. CCRs consist of coal combustion fly ash and bottom ash. All site CCRs not disposed of offsite will be covered with a Geosynthetic Cap and Soil Cover or other erosion resistant cover.

2.01.3. Subgrade Fill

A. The Subgrade Fill will be added soil and/or CCRs placed beneath the geosynthetic cap system as shown on the project drawings. Subgrade Fill shall not be placed beyond the limits of the geosynthetic cap system.

B. The surface of the Subgrade Fill shall be proof-rolled in accordance with Section 3.07. The onsite source for Subgrade Fill shall be approved by the Owner's Representative prior to placement for each application. It shall be free of topsoil and unsuitable material as defined in Subsection 2.01.1.

2.01.4 Protective Cover Soil

A. The bottom 18–inch thickness of the soil cover shall be on-site soils from the borrow area or dam embankment with a maximum particle size of 4 inches. It shall not contain CCRs or unsuitable material as defined in Subsection 2.01.1.

2.01.5 Vegetative Support Layer

A. The top 6 inches of the 24-inch soil cover is the vegetative support layer. Soil material used as vegetative support layer material shall be on-site soils from the borrow area or dam embankment. It may be topsoil or amended Protective Cover Soil, and shall not contain CCRs or unsuitable material as defined in Subsection 2.01.1.

B. The vegetative support layer shall not contain stones, lumps, roots, or similar objects larger than 6 inches in any dimension.

C. Soil material used as the vegetative support layer must be capable of sustaining vegetation as specified in Section "Seeding". The vegetative support layer shall be amended as needed to support vegetation as specified in Section "Seeding".

D. Vegetative Support Layer will not be used beneath roads or lined channels that will not be vegetated. For channels over the geosynthetic cap system, the combined thickness of Protective Cover Soil and channel linings will be a minimum of 24 inches.

2.01.6 Structural Fill

A. Structural fill materials to be used for embankment construction of basins or ponds, foundation material for articulating concrete block mats or as designated on the drawings shall not contain topsoil, CCRs, or unsuitable or contaminated material as defined in Subsection 2.01.1. Structural fill material is described in Table 3. Structural fill for embankment use shall be approved by the Owner's Representative for each application.

2.01.7 Common Fill

A. Common Fill shall be used for filling to the subgrade beyond the limit of the geosynthetic cap system and below the final grade of Surface Impoundments A, B, C, and E, and as shown on the Drawings. Common Fill shall consist of soil from onsite borrow areas, dam embankments or stockpiles. The onsite source for Common Fill shall be approved by the Owner's Representative prior to placement for each application. It shall have a maximum particle size of 12-inches and be free of CCRs, topsoil, and unsuitable materials listed in Subsection 2.01.1.

2.01.8 Low Permeability Soil Liner

A. Soil liner material shall consist of clayey, low-permeability soils. The liner material shall have a coefficient of permeability of 1×10^{-7} cm/sec or less based on ASTM D5084 when compacted to the required density and at the required moisture content determined by the test pad. Suitable materials shall have the same USCS soil classification and similar grain size distribution and liquid and plastic limits as the test pad material that meets the required permeability, and be free of topsoil and CCRs, topsoil, and unsuitable material listed in Subsection 2.01.1. The material shall not contain particles having a maximum dimension greater than 2 inches.

Part 3 Execution

3.01 Test Pad

A. The contractor shall construct a 50-foot by 50-foot by minimum 18-inch thick test pad constructed from low permeability soil liner soil material in an area as directed by the Engineer or Owner's Representative. The test pad shall be constructed using the Contractors proposed soil liner placement equipment including sheepsfoot compactor, bull dozer, and water truck. The purpose of the test pad is to establish a construction method which will yield an acceptable permeability of $1\text{x}10^{-7}$ cm/sec for each source and type of soil used for the low permeability soil liner. The test pad shall be compacted to a minimum of 95 percent of standard proctor density (ASTM D698) at optimum moisture content to +3 percent of the optimum moisture content. The soil for the test pad shall be placed in maximum 8-inch loose lifts and compacted. A water truck may be used for moisture control. The Contractor and QC Team shall report the construction method (number of passes, compaction equipment, etc.). Shelby tube samples shall be obtained from the top 12-inches of the test pad and these undisturbed Shelby tube samples shall be tested for permeability per ASTM D5084 by the QC Team. One Shelby tube sample shall be obtained from each half of the test pad. Upon approval of the test pad construction by the Owner's Engineer, the Contractor shall utilize the test pad construction method to construct the low permeability soil liner.

B. Test pads may also be constructed following GRI GS11 to assess the potential for geomembrane puncture and to evaluate the need for a cushion geotextile.

3.02 Lines and Grades

A. The Drawings indicate existing and proposed contours, as well as typical sections. The Contractor shall be responsible for the setting out of all cuts and fills required to complete the Work.

B. The Drawings indicate reference survey control, which has been established by the Owner. The Work shall be located from this control by the Contractor.

3.03 Excavation

A. Excavation shall conform to the lines and grades shown on the Drawings. Any deviation shall require prior approval of the Owner and Owner's Representative. Excavated areas shall be shaped and fine graded to provide a uniform surface free from windrows, bumps, hollows, and rock fragments. Topsoil shall be stripped and stockpiled from all excavated areas.

B. The Contractor shall grade cut areas to provide positive drainage at all times. Any material which in the opinion of the Owner is rendered unsuitable due to the failure of the Contractor to maintain proper drainage shall be removed and disposed of as unsuitable material and replaced, at the Contractor's expense.

C. Any over-excavation beyond the lines and grades shown on the Drawings that was not directed by the Owner or Owner's Representative shall be brought back to the designated grade(s) with approved material and compacted at the Contractor's expense.

D. The Contractor shall maintain all Contractors haul roads which shall include the application of any dust suppressant to minimize fugitive dust. The dust suppressant used requires prior approval by the Owner.

3.04 Fill Placement

A. All fill shall be placed in lifts (unless shown otherwise on the Drawings). Surfaces shall be provided with sufficient longitudinal and transverse slope to provide positive drainage of surface water.

B. Structural Fill shall be placed in 8-inch loose lifts and compacted to a minimum density equal to 95 percent of the maximum dry density as determined by ASTM D698. The moisture content at the time of placement shall not vary from the optimum moisture content by more than 2 percent. The rock correction procedure shall be applied as indicated by the Owner's Representative.

C. Low permeability soil liner materials shall be placed in maximum 8-inch loose lifts and compacted to a minimum required Standard Proctor Test (ASTM D698) dry density and moisture content of optimum to +3 percent or as determined by the test pad and approved by the Owner's Engineer. The minimum compacted liner thickness shall be one (1) foot. The rock correction procedure shall be applied as indicated by the Owner's Representative.

D. Common Fill shall be placed in 12-inch loose lifts and compacted to a minimum density equal to 90 percent of the maximum dry density as determined by the Standard Proctor Test (ASTM D698). The moisture content at the time of placement shall not vary from the optimum moisture content by more than 3 percent or as determined by the Owner's Professional Engineer based on permeability test results. The rock correction procedure shall be applied as indicated by the Owner's Representative. If 6 to 12-inch sized rocks are encountered the Contractor shall space the rocks in a manner to allow proper compaction of the soil fill around each individual stone.

E. Subgrade Fill shall be placed in maximum 24-inch loose lifts and compacted using equipment of the type and size to provide a firm subgrade for geosynthetic cap system placement. The compaction effort and method shall be approved by the Owner's Representative. If large rocks are encountered the Contractor shall space the rocks in a manner to allow proper compaction of the soil fill around each individual stone.

F. Anchor trench (Geosynthetic Cap System termination) backfill and cover must be placed immediately after placement of the Geosynthetic Cap system. Anchor trench backfill is to be Protective Cover Soil placed or spread at a maximum lift thickness of 6 inches and compacted using equipment of the type and size required to produce 95 percent of Standard Proctor density. Compaction shall be performed in such a manner that no damage of the geosynthetic cap system occurs.

G. Hauling equipment shall not be permitted to repeatedly follow a single track, but shall use different tracks each run in order to provide uniform compaction of the fill.

H. No fill shall be placed while rain is falling unless approved by the Owner or Owner's Representative. Prior to resuming fill operations after rain, all muddy material shall be bladed off the surface to a depth necessary to expose firm compacted material.

I. No fill shall be placed on frozen ground, and no frozen material shall be used for fill.

J. At the end of the day's operation and when rain is threatening, the fill shall be sloped to provide positive drainage and shall be compacted over the entire cross-section and length with a smooth-drum roller to seal it against the entry of water.

K. When the top of the fill or Prepared Subgrade Surface has dried out, become excessively wet, or been damaged by construction equipment, the surface on which additional fill or a structure is to be placed shall be scarified to a minimum depth of 6 inches, brought to the specified moisture content, and recompacted to the specified density prior to the placement of additional fill, geosynthetics, or a structure.

L. Fill which does not meet the requirements for moisture content at the time of compaction shall be dried or wetted to meet the specified requirements. If the fill material requires drying, this may be accomplished by reworking it under warm and dry atmospheric conditions. Water, if required, shall be added carefully by sprinkling and care should be taken that no more than the amount needed is applied. Ponding or flooding shall not be permitted.

M. Where fill is not placed over geosynthetics, sheepsfoot or segmented rollers that are capable of penetrating the full thickness of the lift shall be used to compact cohesive soils and smooth-drum vibratory rollers shall be used to compact granular materials unless otherwise approved. Rubber-tired rollers may be used to compact cohesive and non-cohesive materials with approval of the Owner's Representative.

N. If screening is not performed on Protective Cover Soil, Contractor shall employ a minimum of three (3) people full time with skids to remove oversized material from the Protective Cover Soil and to help flatten wrinkles and prevent damage to geomembrane during placement of the first lift. If screening is performed on Protective Cover Soil, Contractor shall employ a minimum of one (1) person full time help flatten wrinkles and prevent damage to geomembrane during placement of the first lift.

3.05 Geosynthetic Cap System Subgrade Preparation

A. The geosynthetic cap system subgrade shall be compacted to provide a firm subgrade for geosynthetic cap system installation. The compaction effort and method shall be approved by the Owner's Representative.

B. The Contractor shall protect the completed Prepared Subgrade Surface from damage by equipment, trucks, or weather. Any damage to the Prepared Subgrade Surface shall be repaired at the Contractor's expense.

C. The Subgrade Fill shall be placed in accordance with the Subgrade lines and grades shown on the Drawings which promote positive drainage. Any deviation in line and grade from that shown on the Drawings shall require prior approval of the Owner and Owner's Representative.

D. After backfilling or cover placement, disturbed areas shall be fine graded to blend in with existing contours or to elevations as indicated on the Drawings. The finished areas will be left with puddle-free drainage.

E. The Contractor shall be responsible for placing protective cover soil, structural fill and subgrade fill as necessary to create temporary stormwater diversion channels between construction sequences to protect the work. Stormwater Diversions shall be approved by the Owner's Representative and shall be constructed at no additional cost to the Owner.

F. The prepared subgrade surface shall be smooth-drum rolled. The surface shall be worked by the Contractor so it is free of vegetation, large protruding rocks, fractured stone, debris, cobbles, rubbish roots, and sudden changes in slope. Objects shall protrude from the smooth surface no more than 3/8 inch, or as approved by the QC Team.

3.06 Soil Cover

A. The minimum 24-inch Soil Cover shall consist of a minimum 18-inch thick layer of compacted Protective Cover Layer and a minimum 6-inch thick Vegetative Support Layer. The Protective Cover Layer shall be placed on directly over the GDN except where subsurface drainage is placed. The materials shall meet the requirements for Protective Cover Layer and Vegetative Support Layer as required in Section 2.01.3.

B. Protective Cover Soil and Vegetative Support Layer Placement. No equipment shall be operated directly on the surface of geosynthetics without permission from the Owner's Professional Engineer. A 5 to 7 psi low ground pressure (LGP) dozer shall be used to place the Soil Cover layers over the geosynthetics layer. Cover material (soils, geotextiles, geocomposite, pipes, and aggregates) shall not be dropped onto the geomembrane or overlying geosynthetics from a height greater than 3 feet. Protective Cover Layer and Vegetative Support Layer soils shall be placed on the geosynthetics in an upward tumbling motion, and shall be placed from the bottom of the slope upward.

C. Equipment placing Protective Cover Soil shall not stop abruptly, make sharp turns, spin their wheels or travel at speeds exceeding 5 mph. Protective Cover Soil shall be compacted with LGP dozers. Sheepsfoot rollers or other compaction equipment with protrusions that could penetrate the geosynthetics may not be used.

D. A minimum thickness of 3 feet of Protective Cover Soil must be placed over the Geosynthetic Cap System prior to haulage truck traffic over the Geosynthetic Cap System.

E. Tilling, discing, or other mixing of materials into the Vegetative Support Layer shall be performed without damaging underlying geosynthetics. The soil cover shall be placed within plus or minus 0.2-foot of the grades shown on the Drawings and thickness tolerance shall be plus 0.2-foot of the required thickness. Any deviation in line and grade from that shown on the Drawings shall require prior approval of the Owner's Representative. Survey data shall be provided by a Licensed Professional Surveyor to verify the finished soil liner thickness as work progresses.

F. Any portions of the soil cover that are determined to be unacceptable by the Owner or Owner's Representative prior to being covered by the overlying geosynthetics shall be removed and replaced or repaired at no additional cost to the Owner.

G. To promote surface water runoff and reduce excessive drying, the Contractor shall prepare the working surface of the Cover Soil layers using a smooth drum roller as necessary. Prior to placement of additional fill material, the Contractor shall scarify smooth drum rolled surfaces to promote homogeneity between fill lifts.

3.07 Proof-Rolling

A. Within the limits of the geosynthetic cap system installation, the Contractor shall proof-roll the final surface of the Subgrade Fill with at least two passes with approved heavy construction equipment. Unsuitable, soft areas or organic areas and protrusions greater than 3/8 inch shall be over-excavated until material acceptable to the Owner or Owner's Representative is encountered and backfilled with suitable compacted soil.

1. Proof rolling shall be performed with a fully loaded tandem-axle truck or smooth drum roller approved by the Owner's Representative.
2. Confined areas inaccessible to heavy compaction equipment shall be proof-rolled with a minimum of four passes with the largest practicable plate-compactor or walk-behind roller.
3. Steep slopes, which pose an unsafe situation for rollers may be proof-rolled with tracked equipment and an approved towed roller capable of attaining the specified compaction requirements.

B. All proof-rolling shall be performed in the presence of the Owner or Owner's Representative. Proof rolling shall take place after all cuts, fills, and fine grading are complete in the area.

Table 1
Test Procedures for the Evaluation of Soils

Test Method	To Determine	Test Standard
Laboratory Test Procedures		
Moisture Content	Moisture Content	ASTM D2216
Standard Proctor	Moisture/Density Relationship of Soil	ASTM D698
Hydrometer Analysis	Particle Size Distribution of Fine-Grained Soils	ASTM D422
Sieve Analysis	Particle Size Distribution of Course-Grained Soils	ASTM D422 (wet) or ASTM C136
Unified Soil Classification System (USCS)	USCS Textural Classification	ASTM D2487
Atterberg Limits	Plasticity Index	ASTM D4318
Field Test Procedures		
Nuclear Densimeter	Soil Density, Moisture Content	ASTM D6938
Sand Cone/Drive Cylinder (For Checking/Calibration Only)	Soil Density, Moisture Content	ASTM D1556 ASTM D2216 ASTM D2937
Soil Description	Identification of Soils	ASTM D 2488
Ruler, Scale or Elevation Reading	Soil Liner Thickness	--

Table 2
Pre-Qualification Testing

Test	Standard	Material	Frequency
Sieve Analysis With Hydrometer	ASTM D422	Protective Cover Soil, Vegetative Support Soil, Structural Fill, Low Permeability Soil Liner	One per source or visual change
Atterberg Limits	ASTM D4318	Protective Cover Soil, Vegetative Support Soil, Structural Fill, Low Permeability Soil Liner	One per source or visual change
Unified Soil Classification	ASTM D2487	Protective Cover Soil, Vegetative Support Soil, Structural Fill, Low Permeability Soil Liner	One per source or visual change
Moisture/Density Relationship	ASTM D698	Protective Cover Soil on 5H:1V slopes longer than 50 feet and 4H:1V slopes, Structural Fill, Low Permeability Soil Liner, Common Fill	One per source or visual change
Soil Fertility Testing	Per Agronomist recommendation	Vegetative Support Layer	One test per 10 acres
Permeability[(1)]	ASTM D5084	Low Permeability Soil Liner	One per source or visual change

Note:

(1) At 90 or 95 percent D698 maximum dry density (as determined by test pad) at optimum moisture content (OMC) to OMC+3 percent.

Table 3
Monitoring of Soils

Item	Requirement (1)	Minimum Test Frequency/Observation	Acceptance Criteria
1. Subgrade Fill	Verification of subgrade fill, including compaction equipment utilized	Visual observation.	--
	Verification that Subgrade Fill containing CCRs is not placed beyond the Limit of Geosynthetic Cap System.	Visual observation.	
	Verification that unsuitable materials are not in fill as stated in the specifications	Visual observation.	--
	Lift Thickness (when prepared subgrade is fill)	Visual Observation	2-foot (loose) maximum.
2. Prepared Subgrade Surface	Proof-rolling.	Visual observation of the action of the compaction equipment (i.e., penetration, pumping, and cracking). Visual observation of surface condition of prepared subgrade of both cut and fill.	No ruts deeper than 1-inch
	Verification that the final surface is smooth, uniform, and without large protrusions.	Visual observation of entire prepared subgrade surface.	No ruts deeper than 1-inch. No protrusions greater than 3/8 inch (2).
3. Protective Cover Soil Layer	Unified Soil Classification	5H:1V slopes longer than 50 feet and 4H:1V slopes only: One test per acre and one test per soil type	5H:1V slopes longer than 50 feet and 4H:1V slopes only: CL or CH
	Maximum Particle Size	Visual observation	4 inches (3)
	Atterberg Limits	5H:1V slopes longer than 50 feet and 4H:1V slopes only: One test per acre and one test per soil type	5H:1V slopes longer than 50 feet and 4H:1V slopes only: Plasticity Index > 15
	Combustible Content	One test per acre	--
	Field Density/Moisture Tests	5H:1V slopes longer than 50 feet and 4H:1V slopes only: Two in-place density tests per acre per lift. Minimum one tests performed each day that cover is placed.	5H:1V slopes longer than 50 feet and 4H:1V slopes only: 90 percent of standard proctor; +/- 3 percent OMC
	Lift thickness	Visual Observation	The first lift shall be placed in a 14-inch loose lift, and the second lift sufficient to result in total compacted Protective Cover Layer thickness of 18 inches.
4. Vegetative Support Layer	Maximum Particle Size	Visual observation	6 inches
	Lift thickness	Visual Observation	Compacted lift thickness of 6 inches. Total soil cover thickness 24 inches minimum.

Table 3 (Continued)

Item	Requirement	Minimum Test Frequency/Observation	Acceptance Criteria
5. Structural Fill	Field Density/Moisture Tests	Four tests per acre per lift. Minimum one test performed each day that structural fill is placed.	95 percent of ASTM D698 maximum dry density; +/- 2 percent OMC
	Standard Proctor Test	One test for each 40,000 cubic yards of structural fill material placed and one test for each type of material.	--
	Atterberg Limits	Every time a Standard Proctor Test is performed.	PI≥7.
	Unified Soil Classification	Every time a Standard Proctor Test is performed.	SC, ML, or CL or be existing embankment or trench material which is being replaced.
	Maximum Particle Size	Visual observation	2 inches
	Lift thickness	Visual Observation	8-inch loose lifts Unless indicated otherwise
6. Common Fill	Field Density/Moisture Tests	Four tests per acre per lift of common fill. Minimum one test performed each day that fill is placed.	90 percent of D 698 maximum dry density; +/- 3 percent OMC
	Standard Proctor Test	One test for each 40,000 cubic yards of common fill material placed and one test for each type of material.	--
	Maximum Particle Size	Visual observation	12 inch
	Lift thickness	Visual Observation	12-inch loose lifts

Table 3 (Continued)

Item	Requirement	Minimum Test Frequency/Observation	Acceptance Criteria
7. Low Permeability Soil Liner	Unified Soil Classification	One test per acre and one per soil type.	CH or CL or reuse existing low permeability soil liner soil or other augmented compacted clays or soils
	Maximum Particle Size	Visual observation	2 inch
	Standard Proctor Test	One test for each 3,000 cubic yards of cover soil material placed and one test for each type of material.	--
	Atterberg Limits	One test per acre and one per soil type	---
	Field Density/Moisture Tests	Two in-place density tests per acre per lift. Minimum three tests performed each day that low permeability soil liner is placed.	At percent D 698 maximum dry density and MC determined by test pad.
	Test Pad	One per soil source	Permeability less than or equal to $1x10^{-7}$ cm/sec at percent D 698 maximum dry density and MC determined by test pad.
	Permeability	One per acre and one per soil type.	Permeability less than or equal to $1x10^{-7}$ cm/sec determined by in place testing.
	Lift thickness	Visual Observation	8-inch lift thickness.

Notes:

1. Soil Testing will be completed by the QC Team in accordance with the Construction Quality Assurance Plan. Contractor shall coordinate with the CQA Team to ensure all testing is completed as required by these specifications.
2. Cushion Geotextile may be used to allow larger subgrade protrusion, as approved by Owner's Engineer.
3. Acceptable particle size may be re-evaluated using a test pad in accordance with GRI Guide GS11. Test pad geotextile above geomembrane may be replaced with GDN, as appropriate.

-End of Section-

SECTION 02233
Drain Gravel/Coarse Aggregate

Section 02233
Drain Gravel/Coarse Aggregate

Part 1 General

1.01 Description of Work

A. The Contractor shall furnish all labor, materials, equipment, tools, and appurtenances required to complete the work of furnishing, placing and compacting the stone as shown, specified or required. Contractor shall implement and supervise all work.

B. Comply with applicable codes, ordinances, rules, regulations and laws of local, municipal, state, or federal authorities having jurisdiction.

1.02 Related Sections

A. High Density Polyethylene (HDPE) Pipe and Fittings - 02620

B. Geotextile - 02595

1.03 References

The following codes and standards are referenced in this Section:

A. American Association of State and Highway Transportation Officials (AASHTO)

1. AASHTO T104, "Standard Method of Test for Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate"

B. ASTM International (ASTM) Standards:

1. ASTMC136, "Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates"
2. ASTM D422, "Standard Test Method for Particle-Size Analysis of Soils"
3. ASTM D2487, "Classification of Soils for Engineering Purposes (Unified Soil Classification System)"
4. ASTM D2488, "Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)"
5. ASTM D3042, "Standard Test Method for Insoluble Residue in Carbonate Aggregates"
6. ASTM D4253, "Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table"
7. ASTM D4254, "Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density"

Part 2 Products

2.01 Material

A. The material shall be clean, sound, tough, durable, angular, subangular, and free from slag, cinders, ashes, rubbish, or other deleterious material in accordance with VDOT Section 203. Subangular and angular aggregate shall be as defined in ASTM International D2488 entitled "Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)".

B. Aggregate shall be stored in designated areas approved by the Owner. The Contractor is responsible for maintaining the stone free of contamination, and any stone determined by the Owner to be contaminated shall not be incorporated into the work.

C. Coarse Aggregate for access road and drainage pipe bedding shall meet the gradation requirements for Virginia Department of Transportation coarse aggregate for the stone size(s) shown on the Construction Drawings.

2.02 Testing

A. The Contractor shall submit to the Owner's Representative and Owner for approval, certification that the materials proposed for use as coarse aggregate comply with VDOT Section 203 specifications for the proposed application. The certification shall include, but not necessarily be limited to testing or certification of testing provided by the supplier.

B. Underdrain aggregate shall be tested for calcium carbonate content in addition to VDOT aggregate requirements. Soluble carbonate shall not exceed 10 percent by weight.

C. Additional conformance testing may be required by the Owner's Representative/Construction Quality Assurance (CQA) Consultant as specified in the CQA Plan.

D. No material shall be placed unless approved by Owner's Representative.

Part 3 Execution

3.01 Placement

A. Coarse aggregate shall be placed to the lines, depths, and grades as shown on the Drawings.

B. Backfilling of coarse aggregate shall be performed by the Contractor in a manner such that the material is kept clean and free of foreign materials.

C. Bring up the backfill evenly on both sides of the pipe for the full length of the pipe.

D. Pipe bedding and backfill shall be compacted with a minimum of three passes with a plate tamper. A minimum of 14 inches of fill shall be placed over the top of the pipe before trafficking can occur. The compaction effort shall be applied to both the bedding and the backfill around the pipes. The method of compaction shall not damage the pipe, geotextile or the geomembrane.

E. The Owner's CQA Consultant will at any time inspect the stone in the trenches or in stockpile on-Site for contamination and, if necessary, reject all or portions of the stone.

F. The Contractor shall use extreme care in the placing of the material over geosynthetics. The material shall be placed in a manner to maintain a minimum thickness of 12 inches between the geosynthetics and the spreading equipment. All coarse aggregate, placed within the limits of the geosynthetics, shall be placed by low pressure equipment. Equipment with ground pressure less than five pounds per square inch (psi) may travel on a minimum 12-inch thick drain gravel layer over the geosynthetic cap system. Equipment with a ground pressure equal to or greater than five psi must travel on a minimum 36-inch thick layer over the geosynthetic cap system.

Table 1
Test Procedures for the Evaluation of Aggregates

Test Method	To Determine	Test Standard
Laboratory Test Procedures		
Sieve Analysis	Particle Size Distribution of Course-Grained Soils	ASTM D422 (wet) or ASTM C 136
Unified Soil Classification System (USCS)	USCS Textural Classification	ASTM D2487
Calcium Carbonate	To Determine Calcium Carbonate Content of Aggregate	ASTM D3042
Soundness	Determination of soundness of aggregates by use of sodium or magnesium sulfate	AASHTO T104
Relative Density	Relative Density	ASTM D4253 ASTM D4254
Field Test Procedures		
Soil Description	Identification of Aggregate	ASTM D2488
Ruler, Scale or Elevation Reading	Lift Depths	--

Table 2
Pre-Qualification Testing

Test	Standard	Material	Frequency
Sieve Analysis of Aggregates	ASTM C136	VA Department of Transportation (VDOT) #57	One per source
		VDOT Fine Aggregate A	
		VDOT #1	
		VDOT #2	
		VDOT #3	
		VDOT #21B	
		VDOT #8	
Relative Density	ASTM D4253 ASTM D4254	VDOT #57	One per source
Calcium Carbonate	ASTM D3042	VDOT #57 (Underdrain only)	One per source
Soundness of Aggregates	AASHTO T104	VDOT #57	One per source
		VDOT Fine Aggregate A	
		VDOT #2	
		VDOT # 2	
		VDOT # 3	
		VDOT # 21B	
		VDOT #8	

-End of Section-

SECTION 02271
Stone Riprap

Section 02271
Stone Riprap

Part 1 General

1.01 Description of Work

A. The Contractor shall provide all labor, materials, equipment, tools and appurtenances required to complete the work of furnishing and placing stone riprap, as shown, specified or required.

B. Comply with applicable codes, ordinances, rules, regulations and laws of local, municipal, state, or federal authorities having jurisdiction.

1.02 Related Sections

A. Erosion and Sedimentation Control - 02125

B. Geotextiles - 02595

Part 2 Products

2.01 Material

A. Stone riprap and bedding shall consist of hard, durable, subangular material. It shall be free from any considerable amount of flat, laminated, or elongated particles; and shall be free from cracks, overburden shells, clay, organic matter, or other deleterious matter.

B. The riprap shall be composed of Class A1, I or II riprap, as shown on the drawings

C. The breadth or thickness of a single stone shall not be less than one-third its length.

D. Bedding layer for Class II riprap shall be VDOT No. 1 coarse aggregate.

2.02 Submittals

Submit manufacturer's certification of material properties as outlined in Part 2.01 to the Owner's Representative.

Part 3 Execution

3.01 Installation – Loose Riprap

A. Bedding for Class II riprap shall be placed to a thickness of 10 inches.

B. Stone riprap shall be placed to thicknesses as indicated on Contract Drawings.

C. Riprap shall be placed on Separation Geotextile as specified in Section 02595. The edges of the geotextile shall be sufficiently anchored to prevent movement during rock placement.

D. Stone riprap shall be placed in a manner that will not damage geotextile, synthetics, utilities or other facilities. Riprap shall not be dropped from a height exceeding 3 feet.

E. The tolerance in riprap thickness in place shall be -0 to +0.3-foot.

F. No material shall be placed unless approved by the Owner.

-End of Section-

SECTION 02279
Cellular Concrete Mattresses for Erosion Control

SECTION 02279
Cellular Concrete Mattresses for Erosion Control

Part 1 General

1.01 Scope of Work

The Contractor shall furnish all labor, materials, equipment, and incidentals required and perform all operations in connection with the installation of cellular concrete erosion control mats in accordance with the lines, grades, design, and dimensions shown on the Drawings and as specified herein.

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1. ASTM D6884, "Standard Practice for Installation of Articulating Concrete Block (ACB) Revetment Systems"
2. ASTM D7277, "Standard Test Method for Performance Testing of Articulating Concrete Block (ACB) Revetment Systems for Hydraulic Stability in Open Channel Flow"
3. ASTM D7276,"Standard Guide for Analysis and Interpretation of Test Data for Articulating Concrete Block (ACB) Revetment Systems"
4. U.S. Federal Highway Administration (FHWA) and U.S. Bureau of Reclamation (USBR) Report. FHWA-RD-89-199 Hydraulic Stability of Articulated Concrete Block Revetment Systems During Over-topping Flow.

1.02 Delivery, Storage, and Handling of Materials

1.02.1 Delivery and Storage

Materials delivered to the site shall be inspected for damage, unloaded, and stored with the minimum of handling. Materials shall be kept free of dirt and debris.

1.02.2 Handling

Materials shall be handled in such a manner as to ensure delivery to the site in sound, undamaged condition. Separation geotextiles that are not to be installed immediately shall be protected from the direct sunlight and in accordance with the applicable portions of the Section 02595 - Geotextiles.

1.03 Submittals

The Contract shall provide shop drawings to the Owner's Engineer for approval.

The Contractor shall submit to the Engineer all manufacturers' hydraulic testing and calculations in support of the proposed cellular concrete mat system and geotextile. All calculations submitted must be consistent with the details found in Part 2 of this specification.

The Contractor shall furnish the manufacturer's certificates of compliance for cellular concrete blocks/mats, revetment cable, and any revetment cable fittings and connectors as specified in this document. The Contractor shall also furnish the manufacturer's specifications, literature, shop drawings for the layout of the mats, and any recommendations, if applicable, that are specifically related to the project.

The tapered ShoreBlock SD is considered a system composed of (bottom to top) a properly compacted subgrade, a minimum of 6 inches of washed VDOT Fine Aggregate A sand, CCM Geotextile, a minimum of 4 inches of VDOT #57 aggregate, Synteen SR18 geogrid or approved equal, then the tapered CCM blocks placed upon the geogrid and filled with VDOT #57 aggregate.

Alternative materials may be considered. Such materials must be pre-approved in writing by the Owner's Engineer prior to bid date. Alternative material packages must be submitted to the Owner's Engineer a minimum of fifteen (15) days prior to bid date. Submittal packages must include, at a minimum, the following:

Full-scale laboratory test results and associated engineering calculations quantifying the hydraulic capacity of the proposed cellular concrete mat system in similar conditions to the specific project. The laboratory testing and calculations must comply with all items found in Part 2 of this specification. Submitted calculations must be PE stamped by a duly licensed engineer in the jurisdiction of the project.

Part 2 Materials

2.01 Cellular Concrete Mattresses

Cellular concrete mattresses (CCMs) shall be SHOREBLOCK® Model SD-475-OCT or approved equal.

2.01.1 General Product Description

All cellular concrete mats shall be prefabricated as an assembly of concrete blocks, with specific hydraulic capacities, laced with revetment cables.

Individual units in the system shall be staggered and interlocked for enhanced stability. The mats shall be constructed of open cell units only as shown on the contract drawings. The open cell units have two (2) vertical openings of rectangular cross section with sufficient wall thickness to resist breakage during shipping and installation. The open cell units have an open area of 18-23% as measured from the base of the mat. Parallel strands of cable shall extend through two (2) cable ducts in each block allowing for longitudinal binding of the units within the mat and subsequent ability of the blocks to move freely along the cable. Each row of units shall be laterally offset by one-half of a block width from the adjacent row so that any given block is cabled to four other blocks (two in the row above and two in the row below).

Each block shall incorporate interlocking surfaces that minimize lateral displacement of the blocks within the mats when they are lifted by the longitudinal revetment cables. The interlocking surfaces must not protrude beyond the perimeter of the blocks to such an extent that they reduce the flexibility or articulation capability of the cellular mats or become damaged or broken when the mats are lifted during shipment or placement. Once the mats are in place, the interlocking surfaces shall minimize the lateral displacement of the blocks even if the cables should become damaged or removed. The mats must be able to flex a minimum of 18° between any given row or column of blocks in the uplift direction and a minimum of 45° in the downward direction.

The cables inserted into the mats shall form lifting loops at one end of the mat with the corresponding cable ends spliced together to form a lifting loop at the other end of the mat. The cables shall be inserted after sufficient time has been allowed for the concrete to complete the curing process.

The CCMs shall be placed on geogrid as specified herein. Under no circumstances shall the CCM Geotextile or geogrid be affixed (i.e. chemically bonded to the blocks) to the mattress in a manner in which would jeopardize the functionality of the geosynthetics. Specifically, the geosynthetics shall be independent of the block system.

2.01.2 Independent Testing

All CCM systems shall be independently tested by a facility experienced in performing such tests. All testing and the interpretation of the test data shall conform to the following ASTM standards:

1. ASTM D7277 Standard Test Method for Performance Testing of Articulating Concrete Block (ACB) Revetment Systems for Hydraulic Stability in Open Channel Flow
2. ASTM D7276 Standard Guide for Analysis and Interpretation of Test Data for Articulating Concrete Block (ACB) Revetment Systems

In addition to the above guidance standards, the following specific testing, data analysis and FOS computation requirements shall be met:

The design of the cellular concrete mats shall be in accordance with the equations found in "Design Manual for Articulating Concrete Block (ACB) Revetment Systems, Second Edition NCMA 2010"

The analysis shall be performed based upon the stability of the mat due to gravity forces alone, neglecting conservative forces added by cabling, mechanical anchorage, contact with adjacent blocks, or other restraints not attributable to gravity based forces. The analysis must account for a 0.0-inch block projection. Hydraulic jump analysis based on the correlation between energy ratio and Froude ratio shall also be performed and supported by appropriate test results.

Other factors that must be met for the ACB test results include:

1. For design velocities less than 20 feet per second vertical drop of test flume must be a minimum of 10 feet.
2. All ACB's must be tested on a minimum 2H:1V embankment slope.
3. For design velocities greater than 20 feet per second vertical drop of the test flume section must be greater than 20 feet.
4. Hydraulic jump test data provided on a 2:1 slope or on no less of a slope than the project design.
5. Projection height for tapered blocks is set to 0.0".
6. Reported shear values can only be extrapolated with in the same "family" (having identical foot print in terms of both shape and area) and from lighter to heavier blocks.
7. Testing of the ACB system shall have been completed in 2005 or later.

2.01.3 Project Design Parameters

The following are the specific design parameters the CCM system must be designed to for this project:

Property	Value
Velocity	20 ft/sec
Shear	9.3 lb/ft^2
Side Slope	5H:1V
Bed Slope	5.25%

2.01.4 Size of Cellular Concrete Mattresses.

Mat sizes shall be determined during the layout process which is completed once a purchase order for the project has been issued by the Owner or Contractor. Mat size shall not exceed 8' in width or 40' in length unless special provisions are made ahead of time with the design engineer on a specific project. Mat sizes shall be selected to minimize both freight costs and the amount of grout needed for finishing the revetment system.

2.02 CCM Manufacture

All CCMs will be manufactured in accordance with ASTM 6884.

In addition the following specific conditions and properties will be met:

Compressive Strength Net Area Min. p.s.i		Water Absorption Max. lb/ft^3	
Avg. of 3 units	Individual Unit	Avg. of 3 units	Individual Unit
4,000	3,500	10	12

The manufacturer shall meet all requirements pertaining to a concrete unit's durability pertaining to a freeze-thaw environment as specified in ASTM C1262 and as tested fresh water. The test shall be for 100 cycles with less than a 1% mass loss in the blocks submitted for testing.

A certificate of compliance with the test results specified above and in ASTM 6884 completed in the past 30 months shall be submitted from the manufacturing plant to the Contractor.

2.03 Sampling and Testing

The purchaser or their authorized representative shall be accorded proper access to facilities to inspect and sample the units at the place of manufacture from lots ready for delivery. Additional testing, other than that provided by the manufacturer, shall be borne by the purchaser.

2.04 Revetment Cable

Shall be polyester cable as specified in ASTM 6884. Cable size will be determined by block and mat size and shall provide for a 5.0 or greater factor of safety when lifting.

2.04.1 Polyester Revetment Cable

Polyester Revetment Cable shall be constructed of high tenacity, low elongating, and continuous filament polyester fibers. Cable shall consist of a core construction comprised of parallel fibers contained within an outer jacket or cover. The weight of the parallel core shall be between 65 to 70 percent of the total weight of the cable. Additionally, revetment cable shall have the following physical properties:

NOMINAL CABLE DIAMETER (INCH)	APPROXIMATE AVG. STRENGTH (LB.)	WEIGHT/100 FT. (LB.)
1/4	3,700	2.2
5/16	7,000	4.4
3/8	10,000	5.5
1/2	15,000	9.7

2.04.2 Elongation Requirements

Elongation Requirements specified below are based upon stabilized new, dry cable. Stabilization refers to a process in which the cable is cycled fifty (50) times between a load corresponding to 200D2 and a load equal to 10, 20, or 30 percent of the cable's approximate average breaking strength. Relevant elongation values are as shown on the table below. The tolerance of these values is ± 5 percent.

	At % BREAKING STRENGTH		
	10%	20%	30%
Elastic Elongation	0.6	1.4	2.2

2.04.3 Chemical Resistance

Revetment Cable shall exhibit resistance to most concentrated acids, alkalis, and solvents. Cable shall be impervious to rot, mildew and degradation associated with marine organisms. The materials used in the construction of the cable shall not be affected by continuous immersion in fresh or salt water.

2.04.4 Cable and Fittings

Selection of cable and fittings shall be made in a manner that ensures a safe design safety factor for mattresses being lifted from both ends, thereby forming a catenary. Consideration shall be taken for the bending of the cables around hooks or pins during lifting. Revetment cable splicing fittings shall be selected so that the resultant splice shall provide a minimum of 60% of the minimum rated cable strength. Fittings such as sleeves, stops, and washers shall be in accordance with the manufacturer's recommendations unless otherwise shown on the plans.

2.05 Field Installation

Field installation shall be in accordance with ASTM 6884 unless noted below. The section shall consist, from bottom to top, of properly compacted subgrade, minimum 6 inch thickness of sand, CCM Geotextile, a minimum 4 inch thickness of VDOT #57 aggregate, geogrid, and CCM. The open areas of the CCM shall be filled with VDOT #57 aggregate.

Gaps in the revetment system, whether end to end, side to side or around a radius greater than 2 inches shall be filled with 4000 psi non-shrink grout.

2.05.1 System Components

System components shall be as listed below or an equal approved by the design engineer of record. The CCM below has met the hydraulic requirements of this project. It is the contractor's responsibility to select a manufacturer to meet the physical CCM requirements (i.e., compression, absorption, freeze thaw, etc.) as stated in this specification.

Component	Product
CCM	Shoreblock SD 475 OCT
Cable	Polyester
Fittings	Aluminum
Sand	Washed VDOT Fine Aggregate A
Geotextile	CCM Geotextile
Aggregate	VDOT No. 57
Geogrid	Synteen SR18

2.06 Consultation

The manufacturer of the cellular concrete blocks/mats shall provide design and construction advice during the design and initial installation phases of the project when required.

2.07 Geotextile

The CQA consultant shall sample the subgrade soils for the Owner's Engineer to verify the suitability of the selected CCM Geotextile. The Contractor shall schedule the work to allow for the subgrade testing and verification of the CCM Geotextile prior to purchasing the CCM Geotextile.

Table 2.07
Minimum Physical Requirements for CCM Geotextile

Property	Test Method	Criteria
Grab Tensile Strength	ASTM D 4632	315 lbs.
Grab Elongation	ASTM D 4632	50 percent
CBR Puncture Resistance	ASTM D6241	620 lb
Tear Strength	ASTM D 4533	115 lbs
Apparent Opening Size (Acceptable range)	ASTM D 4751	No. 25 to No. 35 sieve 0.710 mm to 0.500 mm
Permittivity	ASTM D4491	18 gpm/ft^2
UV Stability (percent strength retained at 500 hours)	ASTM D 4355	50 (minimum)

2.08 Geogrid

Geogrid shall be Synteen SR18 or Owner's Engineer approved equal.

Part 3 Execution

3.01 Foundation Preparation

3.01.1 Excavation and Preparation

Excavation and Preparation for anchor trenches, side trenches, and toe trenches or aprons shall be done in accordance to the lines, grades, and dimensions shown on the drawings.

3.01.2 Subgrade and Sand Preparation

Subgrade preparation, including existing subgrade and sand layer, shall be in accordance with ASTM D6884. Subgrade shall be compacted, shaped, and uniformly graded to facilitate intimate contact between the CCM system and the subgrade Soil. Prior to placement, VDOT Fine Aggregate A sand shall be washed to remove fines (material passing the No. 200 sieve) to less than 5 percent.

Voids, pits, or depressions shall be scarified and brought to grade by backfilling.

3.01.3 Placement of CCM Geotextile

CCM Geotextile shall be placed in accordance with ASTM D6884. The geotextile shall be placed in intimate contact with the sand and free from folds or wrinkles. The geotextile shall be placed so that upstream strips overlap downstream strips and upslope strips overlap downslope strips. Longitudinal and transverse joints shall be overlapped at least 12 inches and sewn.

3.01.4 Inspection and Approval.

Immediately prior to placing the sand, CCM Geotextile, aggregate, geogrid, and CCM, the prepared area shall be inspected by the owner's representative and approval obtained before any sand, CCM Geotextile or CCM are placed thereon and prior to purchase of the CCM Geotextile, geogrid, and sand material.

3.02 Installation of Cellular Concrete Mattresses

3.02.1 Placement of CCM

CCM shall be placed in accordance with ASTM D6884 except that vertical projections shall not exceed that specified in Section 3.02.2 herein. In areas of curvature or grade change, alignment of an individual block with adjacent blocks shall be such that intimate contact between the geogrid and No. 57 aggregate and between the CCM Geotextile and underlying sand is maintained. CCM placement shall preferably begin at the upstream section and proceed downstream. Block placement shall not bring block-to-block interconnections in tension.

3.02.2 Vertical Projections

Tapered blocks and mats to be installed so as to result in no (0.0") vertical upwards projection of any block in relation to an adjacent upstream block. If a vertical projection exists, the mat shall be removed along with the underlying geogrid, the drainage aggregate shall be regraded, and the geogrid and CCM shall be replaced.

3.02.3 Broken or Damaged Blocks

Mats with broken blocks shall not be accepted. Individual blocks which are damaged or cracked such that the weight of the block is reduced to 1/3 or less of the original block's weight shall be grouted to completely fill the block area prior to the placement of any required surface treatment.

3.02.4 Termination Trenches

Termination trenches shall be backfilled with 4000 psi non-shrink grout approved by the Owner's Engineer. Termination trenches shall be backfilled with specified material flush with the top of the finished surface of the blocks.

3.03 Finishing

3.03.1 Inspection and Approval

Immediately prior to the placement of any required surface treatment per Section 3.02.2, the QC Team shall inspect the installed CCM for defects and/or damage.

3.02.2 Surface Treatment

After the CCM installation is complete, the open cell voids or joints between the CCM shall be filled with VDOT #57 aggregate.

-End of Section-

SECTION 02280
Gabions

Section 02280
Gabions

Part 1 General

1.01 Description

A. Scope:

1. This section covers the general requirements for the construction of drainage and erosion control structures including but not limited to, Gabion Baskets as shown on the Contract Drawings.

1.02 Quality Control

A. Codes, Standards, and Specifications

1. ASTM A641: Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
2. ASTM C127: Test Method of Specific Gravity and Absorption of Coarse Aggregate.
3. ASTM D1203: Test Methods for Volatile Loss from Plastics Using Activated Carbon Methods.
4. ASTM D1242-95: Test Methods for Resistance of Plastic Materials to Abrasion.
5. ASTM D1499: Recommended Practice for Operating Light-and Water-Exposure Apparatus (Carbon -Arc Type) for Exposure of Plastics.

1.03 Submittals

A. The CONTRACTOR shall provide a description of the method of installation of the Gabion Baskets, Reno Mattresses, and stone.

B. Manufacturer's written installation procedures.

C. The manufacturer's product data, indicating the basket dimensions, mesh opening sizes, wire sizes and thicknesses of protective coatings shall be submitted to the ENGINEER at least four weeks prior to delivery to the site.

D. The supplier's certification of gradation shall be submitted to the ENGINEER, at least two weeks prior to the delivery of material to the site. The CONTRACTOR shall submit test reports for soundness, durability, and specific gravity.

Part 2 Products

2.01 Acceptable Manufacturers

A. Maccaferri Gabions, Inc. of Ramsey, New Jersey

B. Or Equal

2.02 Gabion Baskets

A. Baskets shall be manufactured in such a manner that their sides, ends, lid, and diaphragms can be assembled to form rectangular units of the specified dimensions. The front, base, back, and lid shall be woven into a single unit. The ends and diaphragms shall be factory connected to the base.

B. All perimeter edges of the mesh shall be securely selvedged so that the joints obtained have at least the same strength as the wire mesh itself.

C. The horizontal width of individual Gabion Baskets and Reno Mattress shall not be less than 36 inches except as noted on the Drawings. Where the mattress length exceeds 1-1/2 times its horizontal width, the mattress shall be divided into cells by diaphragms of the same mesh and gauge as a unit body.

D. The basket structure shall be a hexagonal shaped mesh pattern that under stress will deform but not break. The mesh openings for the Gabion Basket shall measure approximately 3-1/4 inches by 4-1/2 inches, uniform in size. All mesh joints shall be flexible and double twisted to prevent unraveling.

E. The mesh for the Gabion Baskets shall be galvanized steel wire, having a minimum amount of zinc coating of 0.80 oz/sf of wire and additionally coated with a minimum of 0.020 inch nominal thickness of gray PVC, which shall be suitable to resist destructive effects of immersion in acidic, salt or polluted water, exposure to ultraviolet light and abrasion, and retain these characteristics under test conditions in accordance with ASTM B117, D1499, and D1203.

2.03 Mesh Wire

A. The nominal diameter of the basket mesh wire shall not be less than 0.1063 inches (U.S. Gauge No. 12) for the Gabion Baskets after zinc coating, and have an overall nominal diameter (core wire plus PVC coating) of not less than 0.1463 inches for the Gabion Baskets.

2.04 Selvedge Wire

A. The nominal diameter of the selvedge wire (perimeter wire), running through all the edges, shall not be less than 0.1339 inches (U.S. Gauge NO. 10) for the Gabion Baskets after zinc coating and have an overall nominal diameter (core wire plus PVC coating) of not less than 0.1739 inches for the Gabion Baskets.

2.05 Lacing Wire

A. The nominal diameter of the wire, for assembling and lacing, shall not be less than 0.0866 inches (U.S. Gauge No. 13) for the Gabion Baskets after zinc coating and have an overall nominal diameter (core wire plus PVC coating) of 0.1266 inches for the Gabion Baskets.

2.06 Fill Stone

A. See Section 02271 for fill stone requirements.

Part 3 Execution

3.01 Product Delivery, Storage, and Handling

A. No material shall be delivered to the site prior to approval by the ENGINEER.

B. Inspect materials delivered to Site for damage. Remove all damaged or flawed material from the Site.

C. Do not store material directly on the ground. Arrange with the ENGINEER for adequate storage.

D. Carry bundles to work place; dragging of baskets or bundles will not be permitted.

3.02 Subgrade Preparation

A. The subgrade shall be graded as smooth as possible, clear of sharp objects, boulders, or stumps. Soft or unstable areas shall be repaired and compacted to the required subgrade level at no additional cost. The Separation geotextile as specified in Section 02595 shall be placed on the prepared subgrade before placing the Gabion Baskets.

3.03 Assembling

A. Gabion and Reno Mattresses shall be assembled in strict accordance with the manufacturer's written instructions prior to placement at the proposed locations.

B. Single baskets units shall be removed from the bundle, unfolded on a hard flat ground, and all kinks and bends flattened.

C. The baskets units shall then be assembled individually, by erecting the sides, front, and back panels to a right angle by stepping on the base along the crease. Fold up the end, and diaphragm(s) and fasten them to the front and back panels, ensuring that all creases are in the correct position and the tops of all sides level.

D. The four corners of the baskets unit shall be laced first, followed by the edges of internal diaphragm(s) to the sides.

E. The lacing procedure shall consist of cutting a length of lacing wire approximately 1-1/2 times the distance to be laced but not to exceed 5 feet. Secure the wire terminal at the corner by looping and twisting, then proceed to lace with alternating single and double loops at approximately five-inch intervals. Securely fasten the other lacing wire terminal.

3.04 Installation

A. Placing:

1. After assembly, place the assembled basket units in their proper location as shown on the Drawings. For structural integrity, lace all adjoining empty baskets along the perimeter of all contact surfaces.
2. Once the basket units are laced together, they shall be stretched to effective alignment without deformation. This operation shall be carried out after several empty mattress units have been positioned. The first basket in the line shall be partially filled to provide the necessary anchorage. Any stretching shall be carried out using a fence stretcher or other means of at least one ton capacity.

B. Filling:

1. Gabion Baskets units shall be filled with the specified stone.
2. Exercise care when placing fill material to assure that the sheathing on PVC coated baskets will not be broken or damaged.
3. Place stone in three-inch thick lifts. Place two connecting wires between each lift along all exposed faces of the baskets. Loop all connecting wires around two mesh openings and securely twist the wire terminals to prevent their loosening.
4. Fill the cells in any row in stages so that local deformation may be avoided. At no time shall any cell be filled to a depth exceeding its specified depth.
5. Along all exposed basket faces, carefully place and pack by hand the outer layer of stone in order to provide proper alignment and a neat, compact, square appearance.

6. Baskets shall be well packed and filled without undue bulging, and provided with secure lacing.

C. Closing:

1. The lids shall be stretched tight over the filling, using crow bars or lid closing tools, until the lid meets the perimeter edges of the front and end panels.
2. The lid shall then be tightly laced along the edges, ends and diaphragm(s) in the same manner as described above for assembling.

D. Cutting and Folding Mesh:

1. Where shown or as required, the CONTRACTOR shall cut the basket mesh, folded and wired together to suit existing site conditions. The mesh must be cleanly cut and the surplus mesh cut out completely, or folded back and neatly wired to an adjacent mattress face. The cut edges of the mesh shall be securely laced together with lacing wire in the manner described above for assembling.

-End of Section-

SECTION 02590
Geocomposite Drainage Net

Section 02590
Geocomposite Drainage Net

Part 1 General

1.01 Summary

A. Contractor shall furnish all supervision, labor, products, equipment, and tools, including all necessary and incidental items as detailed or required, to install geocomposite drainage net (GDN) in accordance with the Drawings, Specifications, and project Construction Quality Assurance (CQA) Plan.

1.02 References

A. ASTM International (ASTM) Standards:

1. D 792, "Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement".
2. D 1238, "Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer".
3. D 1505, "Standard Test Method for Density of Plastics by the Density-Gradient Technique".
4. D1505, "Standard Test Method for Density of Plastics by the Density-Gradient Technique".
5. D 1603, "Standard Test Method for Carbon Black in Olefin Plastics".
6. D 3786, "Test Method for Bursting Strength of Textile Fabrics: Diaphragm Bursting Strength Tester Method".
7. D4218, "Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds By the Muffle-Furnace Technique".
8. D 4355, "Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture, and Heat in a Xenon-Arc Type Apparatus".
9. D 4491, "Test Methods for Water Permeability of Geotextiles by Permittivity".
10. D 4533, "Test Method for Trapezoidal Tearing Strength of Geotextiles".
11. D 4632, "Test Method for Grab Breaking Load and Elongation of Geotextiles".
12. D 4716, "Test Method for Determining the (In-Plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head".
13. D 4751, "Standard Test Method for Determining Apparent Opening Size of a Geotextile".
14. D 4833, "Test Method for Index Puncture Resistance of Geomembranes and Related Products".
15. D 5199, "Test Method for Measuring Nominal Thickness of Geosynthetics".
16. D 5261, "Test Method for Measuring Mass per Unit Area of Geotextiles".

17. D 5321, "Test Method for Determining the Shear Strength of Soil-Geosynthetic and Geosynthetic-Geosynthetic Interfaces by Direct Shear".
18. D6241, "Standard Test Method for Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe"
19. D7005, "Standard Test Method for Determining the Bond Strength (Ply Adhesion) of Geocomposites"

1.03 Definitions

A. Minimum Average Roll Value (MARV): For geosynthetics, the mean value minus two standard deviations calculated from documented quality control test results for a defined population for one specific test method associated with one specific property.

B. Maximum Average Roll Value (MaxARV): For geosynthetics, the mean value plus two standard deviations calculated from documented quality control test results for a defined population for one specific test method associated with one specific property.

1.04 Submittals

A. Contractor shall be responsible for timely submittals to the Owner's Representative and Owner.

B. The following submittals shall be provided:

1. The GDN and GDN Manufacturer must be approved by the Owner's Representative and Owner prior to Contract award. Submittals for approval include:
    a. GDN Manufacturer's specification sheet(s) demonstrating compliance with the requirements of Table 1 of this Section.
    b. GDN Manufacturer's transmissivity test results. GDN transmissivity test procedures and results shall comply with the requirements of Table 1 of this Section. Include two samples of finished GDN, one-sq. yd. each, for possible transmissivity confirmation testing by the Owner's Representative.
    c. Written certification that the GDN Manufacturer has produced a minimum of 10,000,000 square feet of GDN that has been installed for hydraulic containment purposes in the last 2 years, including a list of the relevant completed facilities. Each entry in this list should include the name, location, and purpose of the facility; GDN product designation, total square footage, and date of installation. Names of the Owner, Designer, GDN Installer, and the name and telephone number of a contact at the facility who can discuss the project shall be provided upon request.
    d. A copy of the GDN Manufacturer's manufacturing quality control (MQC) manual. This manual should describe the quality control program(s) for GDN components (geonet, nonwoven geotextile, etc.) and finished GDN, and indicate the properties, test methods, and testing frequencies used for each. GDN Manufacturer shall modify the MQC manual to comply with the requirements of these Specifications, with any variations, deviations, or exceptions clearly noted in an attached letter.
2. Manufacturer's data shall be provided that shows that the GDN will meet the interface shear strength requirements of Table 2 of this Section. Submittals for approval include:

a. Previous interface shear strength test results for GDN against geomembrane. Conformance test procedures for this interface are outlined in Table 2 of this Section.

b. GDN shall only be approved for use with the conformance tested geomembrane. Changes in geomembrane product will require retesting and re-approval of the GDN at no cost to Owner.

3. The GDN Installer must be approved by the Owner's Representative and Owner prior to Contract award. Submittals for approval include:

a. Written certification that the GDN Installer has installed a minimum of 2,000,000 square feet of GDN for hydraulic containment purposes in the last 2 years, including a list of the relevant completed facilities. Each entry in this list should include the name, location, and purpose of the facility; GDN product designation, total square footage, and date of installation; names of the Owner, Designer, Primary Contractor, and CQA Consultant; and the name and telephone number of a contact at the facility who can discuss the project.

b. A copy of the GDN Installer's CQA manual. This manual should describe the quality control program(s) for handling, deploying, anchoring, seaming, and repairing GDN. GDN Installer shall modify the CQA manual to comply with the requirements of these Specifications and the project CQA Plan, with any variations, deviations, or exceptions clearly noted in an attached letter.

C. The following submittals shall be provided after award of Contract:

1. GDN Manufacturer:

a. Prior to or coincident with shipment of GDN to the project site, submit written certification and supporting test data documenting that all GDN components and finished GDN shipped to the project site comply with the requirements of Part 2.03 of this Section. This shall include:

1) High density polyethylene (HDPE) geonet and nonwoven polypropylene (PP) geotextile resins (Part 2.03.C of this Section). Certifications shall state the producers, product designations, lot or batch numbers, and production dates of all resins used in the manufacture of GDN components shipped to the project site and shall include copies of all quality control certificates issued by the resin producer.

2) HDPE geonet and nonwoven PP geotextile formulations (Part 2.02B of this Section). Certifications shall state that all formulations used to produce GDN components shipped to the project site comply with the requirements of Part 2.02.B of this Section.

3) Finished HDPE geonet and nonwoven PP geotextiles (Part 2.03 of this Section). Certifications shall include copies of all quality control certificates issued by the Geonet and Geotextile Manufacturers. Include two samples of finished geonet and finished geotextile, one square yard each, for the project records of the Owner's Representative and CQA Consultant. Each sample

shall be labeled with the manufacturer's name, product designation, lot number, roll number, and date of sampling.

4) Finished GDN shipped to the project site (Part 2.06.F of this Section). Certifications shall include GDN Quality Control Certificates that have been reviewed and signed by a responsible representative of the GDN Manufacturer.

2. GDN Installer:

a. Four weeks prior to shipment of GDN to the project site, submit six full sets of field installation drawings for approval to the Owner's Representative. Installation drawings shall show the proposed length, width, and position of all GDN panels and the location of all field seams. GDN panels shall have a distinct identification system. Installation drawings shall also show complete details for field seaming and repairs, anchoring GDN at the perimeter of the installation area, and attachments to structures and other penetrations, as required.

b. Within 4 weeks after completion of GDN installation, submit a written report containing the following:

1) Written certification stating that the GDN has been installed in accordance with the Contract Drawings, Specifications, and project CQA Plan.

2) Product and installation warranties as required by Part 3.08 of this Section.

3) Copies of daily field records.

4) As-built drawings depicting actual GDN panel placement and all associated details. As-built GDN plans ("panel diagrams") shall be prepared at a reasonable engineering scale using Contractor's surveyed edge of GDN limits (perimeter cap termination areas, runouts, etc.), and shall accurately depict panel orientations and dimensions..

1.05 Construction Quality Assurance

A. GDN CQA will be performed by the GDN Installer and the Owner's Representative in accordance with the specifications and the project CQA manual.

Part 2 Products

2.01 Geonet

A. The physical, mechanical, and chemical properties of the geonet shall comply with the requirements of Table 1 of this Section.

B. Geonet formulation shall consist of at least 97 percent (by weight) polyethylene resin, 2 percent to 3 percent (by weight) of carbon black [added for ultraviolet (UV) radiation resistance], and a maximum of one percent (by weight) of other additives. No plasticizers, fillers, extenders, post-consumer resin (PCR), or other materials shall be mixed into the formulation. Regrind, rework, or trim materials may be added to the formulation if they are produced by the Geonet Manufacturer and are of the same formulation as the geonet being produced. Regrind, rework, and trim materials shall not exceed 10 percent (by weight) of the geonet formulation.

C. Polyethylene resin used in the manufacture of geonet is to be made from virgin, uncontaminated ingredients and shall be designed and manufactured specifically for producing geonet. Incoming resin shall be sampled and tested in accordance with the Geonet Manufacturer's MQC program. Testing frequencies, test procedures, and resin properties shall comply with the requirements of Table 1 of this Section. Results from the resin sampling and testing program are to be submitted to the Owner's Representative in accordance with Part 1.04.C.1.a.1 of this Section.

D. Geonet shall be sampled and tested, prior to incorporation into finished GDN, in accordance with the GDN Manufacturer's approved MQC manual. Testing frequencies, test procedures, and HDPE geonet properties shall comply with the requirements of Table 1 of this Section. Results from the geonet sampling and testing program are to be submitted to the Owner's Representative in accordance with Part 1.04.C.1.a.3 of this Section.

2.02 Geotextile

A. Geotextiles used in the manufacture of GDN shall be nonwoven needle-punched PP. The physical, mechanical, and chemical properties of the geotextiles shall comply with the requirements of Tables 1 or 3 of this Section, as appropriate. During production, geotextile shall be continuously inspected for the presence of broken needles, which shall be removed from the finished product.

B. Geotextile formulation shall consist of at least 95 percent (by weight) PP resin, one percent to 3 percent (by weight) of carbon black (added for UV radiation resistance), and a maximum of 2 percent (by weight) of other additives. No plasticizers, fillers, extenders, PCR, or other materials shall be mixed into the formulation. Rework or trim materials may be added to the formulation if they are produced by the Geotextile Manufacturer and are of the same formulation as the geotextile being produced. Rework and trim materials shall not exceed 10 percent (by weight) of the geotextile formulation.

C. PP resin used in the manufacture of nonwoven geotextile is to be made from virgin, uncontaminated ingredients and shall be designed and manufactured specifically for producing geotextile. Incoming resin shall be sampled and tested in accordance with the Geotextile Manufacturer's MQC program. Testing frequencies, test procedures, and resin properties shall comply with the requirements of Tables 1 or 3 of this Section, as appropriate. Results from the resin sampling and testing program are to be submitted to the Owner's Representative in accordance with Part 1.04.C of this Section.

D. Geotextile components of the GDN shall be sampled and tested, prior to incorporation into finished GDN, in accordance with the GDN Manufacturer's approved MQC manual. Testing frequencies, test procedures, and PP nonwoven geotextile properties shall comply with the requirements of Tables 1 or 3 of this Section, as appropriate. Results from the geotextile sampling and testing program are to be submitted to the Owner's Representative in accordance with Part 1.04.C of this Section.

2.03 Geocomposite Drainage Net

A. The GDN and GDN Manufacturer must be approved by the Owner's Representative and Owner prior to Contract award, as required by Part 1.04.B. of this Section.

B. GDN shall consist of a HDPE geonet with nonwoven geotextiles thermally-bonded to its upper and lower surfaces. The physical, mechanical, and chemical properties of the GDN shall comply with the requirements of Tables 1 and 2 of this Section.

C. Geonet used in the manufacture of GDN shall be in accordance with the requirements of Part 2.01 of this Section.

D. Geotextile used in the manufacture of GDN shall be in accordance with the requirements of Parts 2.02A and 2.02B of this Section.

E. Bonding of the nonwoven geotextiles to the geonet shall be completed in a uniform manner using thermal bonding techniques. Adhesive bonding is not acceptable. Minimum ply adhesion of the thermally bonded surfaces shall be as required in Table 1 of this Section. GDN shall be produced with unbonded panel edges to facilitate field seaming. Unbonded panel edges are to have a minimum width of 3 inches and maximum width of 6 inches. Nonwoven geotextile shall extend a minimum of 3 inches beyond the edges of the geonet on both sides of the GDN.

F. During production, finished GDN shall be sampled and tested in accordance with the GDN Manufacturer's approved MQC manual. Testing frequencies, test procedures, and finished GDN properties shall comply with the requirements of Table 1 of this Section. Results from the finished GDN sampling and testing program, in the form of Quality Control Certificates, are to be submitted to the Owner's Representative for approval.

G. GDN shall be produced free of holes, tears, overheated areas, unbonded areas (except for panel edges), contamination by foreign matter, dimensional abnormalities, or other defects. The Owner's Representative may reject all or portions of units (rolls) of GDN shipped to the project site if significant production flaws are observed.

H. GDN shall be manufactured as a continuous panel having a nominal width of 14 feet and minimum length of 200 feet in order to reduce the amount of field seaming required during installation. Rolls of GDN having lengths shorter than 200 feet may be shipped to the project site if the number of such rolls is approved by the Owner's Representative prior to shipment.

I. GDN shall be rolled onto hollow cores having a minimum inside diameter of 4 inches to allow the use of a stinger or spreader bar assembly for handling and deployment. Cores shall be of stable construction such that they support the roll without excessively deflecting, buckling, or otherwise failing during handling, transportation, and storage. Each roll of GDN shall be protected by wrapping it in packaging that is waterproof, resistant to photodegradation by UV light, and completely covers all exposed GDN surfaces and edges.

J. Each GDN roll shall be labeled to identify the GDN Manufacturer, product designation, manufacturer's lot number, manufacturer's roll number, and the length, width, and weight of each roll. Roll identification numbers shall conform to the numbering system established on the GDN Manufacturer's Quality Control Certificates. Labels shall be weather proof, legible, and located so that each roll of GDN can be identified by examining the outside of the roll or the core ends.

K. At the option of the Owner, the Owner's Representative may inspect the GDN manufacturing process on a full-time basis. This inspection program would include conformance sampling as required. If requested, GDN Manufacturer shall submit a production schedule to the Owner and cooperate with the Owner's Representative during plant inspection.

L. All GDN components and finished GDN properties, including testing frequencies and test procedures used, shall meet the requirements of this Section. No GDN shall be installed until the Owner's Representative has reviewed all certifications and supporting test data and determined that the GDN delivered to the project site is acceptable for use. Manufacturing records, including test data, shall be maintained by the GDN Manufacturer for 2 years after acceptance of the GDN, and shall be made available upon request.

2.04 Plastic Ties

A. Plastic ties shall be used to join and make repairs to GDN panels in the field. Ties shall be colored white or yellow to facilitate CQA inspection. Metallic ties or fasteners are not acceptable.

Part 3 Execution

3.01 Pre-Installation Meeting

A. Prior to scheduled GDN installation, the Owner, Owner's Representative, CQA Consultant, Contractor, and GDN Installer shall attend a pre-installation meeting at the project site.

B. GDN Installer shall be represented by both the project field superintendent and the project manager.

C. At the pre-installation meeting, site safety and rules of operation, scheduling, methods of installation, and CQA and quality assurance shall be discussed. The GDN Installer, Owner's Representative, and CQA Consultant shall at this time agree to the required GDN placement, seaming, and repair procedures for the project.

3.02 Shipping, Handling, and Storage

A. Contractor is responsible for proper shipping, unloading, and storage of the GDN. GDN damaged during shipping, unloading, or storage shall be repaired or replaced at no cost to Owner.

B. GDN rolls shall be packaged and shipped so that no damage is caused during delivery to the project site. GDN shipping shall be by open or enclosed trailers loaded in such a manner that rolls can be readily unloaded at the project site using slings, a stinger, or a spreader bar assembly. GDN rolls shipped by open trailer shall be protected with a sacrificial or temporary cover during shipment.

C. During unloading at the project site, Contractor shall conduct a surface inspection of all GDN rolls for defects and damage, including damage to the original protective packaging. Contractor shall immediately notify CQA Consultant and Owner of any defects or damage observed.

D. Extreme care shall be taken by all personnel while unloading and handling GDN. Equipment used to unload and handle GDN shall have sufficient capacity to manage the roll weight without damaging the GDN. GDN shall only be unloaded and handled using slings, a stinger, or a spreader bar assembly recommended by the GDN Manufacturer or accepted by the CQA Consultant. Pushing, sliding, or dragging of GDN rolls is not permitted. CQA Consultant shall have the option of inspecting all GDN panels, prior to final placement, to verify that all defects or damage are identified for repair.

E. GDN shall be stored at the project site in an area(s) designated by the Owner and accepted by the CQA Consultant. Contractor shall grade the storage area so that it is reasonably level and well-drained, and shall prepare the ground surface so that it is firm, smooth, and free of stones, sticks, or other materials that may damage the GDN.

F. GDN rolls shall be stored off the ground and continuously supported along their length. Stacking of GDN rolls for storage is allowed but should not be so high that crushing of cores or flattening of rolls occurs. In general, the maximum stacking limit is five rolls high. A suitable means of securing the rolls shall be used so that shifting or other adverse movement does not occur.

G. During storage, GDN shall be protected from moisture, direct sunlight, mud, and excessive dust by covering the rolls with a plastic sheet or waterproof tarpaulin. Roll labels shall remain intact and legible. Any roll of GDN that has no label or where the label is damaged or otherwise illegible may be rejected by the CQA Consultant. GDN rolls shall be kept in their original protective packaging until immediately before they are to be deployed.

3.03 Quality Assurance Conformance Testing

A. Quality assurance conformance testing of the GDN shall be performed by the CQA Consultant and paid for by the Owner. Conformance sampling and testing shall be completed in accordance with the project CQA Plan, with at least one sample per production lot as directed by the Owner's Representative. Owner has the option to increase the frequency of conformance testing or to sample and test any questionable roll or lot.

B. Conformance testing of the GDN shall include, but not be limited to, the following properties:

   1. Transmissivity, ASTM D 4716
   2. Ply Adhesion, ASTM D7005
   3. Interface Shear Strength, ASTM D 5321

C. Engineer may revise the test methods used for determination of conformance properties to allow for use of new or revised methods.

D. All GDN conformance test results shall comply with the requirements of Tables 1 and 2 of this Section prior to installation. Any GDN that does not conform to these requirements shall be retested or rejected in accordance with the CQA Plan.

E. GDN that is rejected shall be removed from the project site and replaced at no cost to Owner. Sampling and conformance testing of GDN supplied as replacement for rejected material shall be performed by the CQA Consultant at Contractor's cost.

3.04 Deployment and Placement

A. GDN installer shall sign a letter accepting the condition of the geomembrane.

B. GDN shall be deployed and placed in general accordance with the GDN Installer's approved field installation drawings. Depending on field conditions, it may be necessary to alter the GDN panel arrangement from that shown on the approved field installation drawings. These alterations shall be approved by the CQA Consultant prior to GDN deployment.

C. The Owner's Representative and Owner, in conjunction with the GDN Installer and Contractor, shall establish site-specific limits of weather conditions, including, but not limited to, precipitation and wind speed and direction, within which GDN panel placement can be conducted. In the absence of site-specific criteria, the following limitations shall apply:

1. No placement shall be conducted in the presence of precipitation, such as rain, snow, or sleet.
2. No placement shall be conducted in the presence of winds in excess of 20 miles per hour or when dirt or debris is blown into working areas.

D. GDN Installer shall maintain a daily field record of actual placement of each GDN panel, noting subgrade conditions, weather, panel numbers placed, and seaming methods. A copy of each day's field record shall be furnished to the CQA Consultant no later than the following work day.

E. GDN shall only be placed on geomembrane that has been installed in accordance with the Drawings and Specifications, and has been accepted in writing by the Contractor, GDN Installer, and CQA Consultant. Once geomembrane has been accepted by the CQA Consultant, any additional surface preparation that the Contractor or GDN Installer feels necessary to meet the requirements of the Specifications shall be the responsibility of the Contractor. Geomembrane should have all folds, wrinkles, and other undulations removed and its surface shall be free of rocks, dirt, tools, or other debris before placing GDN. Areas the GDN Installer believes exhibit deficient subgrade conditions shall be reported to the CQA Consultant and Owner for repair.

F. GDN Installer shall coordinate placement of the GDN with placement of the covering material. All GDN panels shall be appropriately covered within 2 weeks after they are placed to prevent deterioration of the upper geotextile. Any GDN that deteriorates or is otherwise damaged prior to placement of covering material shall be removed and replaced by the GDN Installer, as directed by the CQA Consultant, at no cost to Owner.

G. It is imperative to keep surface water runoff containing sediment or other debris from contacting the GDN at all times during installation. GDN Installer's panel placement techniques and covering schedule shall minimize or eliminate the potential for accumulation of sediment or other debris on the GDN. GDN Installer shall remove accumulated sediment or debris by sweeping, hosing, or other methods acceptable to the CQA Consultant, prior to covering the GDN. Any GDN that cannot be adequately cleaned shall be removed and replaced by the GDN Installer, as directed by the CQA Consultant, at no cost to Owner.

H. Extreme care shall be taken by all personnel while handling, unwrapping, deploying, and placing GDN. Equipment and tools used shall not stretch, tear, crimp, fold, or otherwise damage the GDN, and shall not cause damage to the underlying geomembrane. Equipment shall have sufficient capacity to manage the roll weight without damaging the GDN. GDN shall only be handled and deployed using a stinger or spreader bar assembly recommended by the GDN Manufacturer or acceptable to the CQA Consultant. Pushing, sliding, or dragging of GDN rolls is not permitted.

I. Under no circumstances shall any construction or vehicular traffic be allowed to drive over exposed GDN. GDN showing evidence of trafficking shall be inspected by the GDN Installer, Contractor, and CQA Consultant to evaluate damage, if any. At the direction of the CQA Consultant, any damaged GDN shall be repaired or replaced at no cost to Owner. CQA Consultant may allow limited use of four-wheeled all-terrain vehicles or other low ground pressure equipment (having 6 pounds per square inch or less contact pressure) by the GDN Installer during installation, but use shall be prohibited if excessive trafficking or any GDN damage is observed.

J. GDN rolls shall be transported from the storage area to the working area in their original protective packaging. After packaging is carefully removed, GDN shall be unrolled and placed in such a manner as to minimize dragging of panels into position ("spotting"). The GDN shall not be dragged across textured geomembrane. A temporary smooth geosynthetic subgrade covering ("slip sheet") shall be used to protect the bottom surface of the GDN from damage, as directed by the CQA Consultant.

K. GDN Installer shall immediately provide temporary anchorage of the GDN to prevent wind uplift, bridging (refer to Part 3.04.L of this Section for bridging requirements), and panel movement during placement of covering materials. No permanent bonding of GDN to geomembrane shall be permitted. Temporary anchorage methods shall be approved by the Owner's Representative and CQA Consultant. If bags are used for temporary anchorage, they shall be filled with aggregate, sand, or soil that has been approved for use by the CQA Consultant. Any GDN exhibiting damage due to insufficient or improper temporary anchorage shall be repaired or replaced, as directed by the CQA Consultant, at no cost to Owner.

L. GDN shall be installed so that is in continuous contact with the underlying geomembrane surface, without being tensioned, and with no wrinkles or folds. Bridging at the toe of slopes or within pipe trenches shall not be permitted. If bridging is observed, GDN Installer shall repair affected areas, as directed by the CQA Consultant, at no cost to Owner.

M. GDN panel seams (edges) shall be oriented in a direction parallel to the line of maximum subgrade slope (i.e., down, not across the slope) and shall be placed in a manner that minimizes the number and length of field seams. In corners and odd-shaped geometric locations where panel seams are staggered or butted, an extra layer of GDN shall be installed from the crest to the toe of the slope.

N. All GDN panel seams parallel to the toe of a slope ("longitudinal seams") shall be located at least 5 feet from the toe of the slope, except where explicitly approved by the CQA Consultant. Longitudinal seams are permitted on sideslopes, but must be staggered in a manner approved by the Owner's Representative and CQA Consultant.

O. Contractor shall be responsible for excavation, maintenance, and backfilling of the perimeter liner termination area in accordance with the perimeter liner termination area requirements outlined in Section 02597 – Linear Low Density Polyethylene Geomembrane, of the Specifications. Backfilling of the perimeter liner termination area shall commence only after the GDN has been approved by the CQA Consultant. Backfilling materials and compaction methods shall be as outlined in Section 02200 – Earthwork of these Specifications.

3.05 Seaming

A. A combination of lap joints (geonet) and sewing (geotextile) shall be used to join GDN panels in the field. A minimum geonet overlap of 3 inches shall be used for panel edges and a minimum GDN overlap of 24 inches shall be used for panel ends. Overlap areas shall be kept free of rocks, loose soil, or other debris. All GDN panels should be seamed as soon as possible after they are placed and prior to being covered.

B. Geonet overlaps along panel edges shall be secured using a minimum of one plastic tie per 5 linear feet of seam except in perimeter liner termination areas, where spacing shall be a minimum of one plastic tie per 6 linear inches of seam. Geonet overlaps in corners or other odd-shaped geometric locations where panel seams are staggered or butted shall be secured using a minimum of one plastic tie per 6 linear inches of seam. GDN panel end seams shall be secured using a minimum of one plastic tie per 6 linear inches of seam, this requirement may be omitted on flat slopes if approved by the Owner's Engineer and Manufacturer. At the panel butt ends, geotextile of the same weight as the top geotextile on the GDN shall be placed over the GDN overlap and heat bonded to the adjoining GDN panels, with a minimum overlap of 12 inches on either side.

C. GDN panel edge overlap areas shall be left open (i.e., upper geotextiles pulled back) after placing plastic ties to allow the CQA Consultant to verify that the overlap area and tie spacing meet the requirements of this Section. Geotextile overlaps shall not be closed and sewn until verbal acceptance of the geonet seam is given by the CQA Consultant.

D. Geotextile overlaps on GDN panel edges shall be joined with a flat ("prayer") seam using two rows of Type 401 stitching. All sewn seams shall be continuous and completed using thread made from the same type of polymer as the geotextiles being sewn together. Sewing thread should be a color that contrasts the geotextile color. Thermal seaming methods may be accepted if successfully demonstrated in the field and approved by the Owner's Representative and CQA Consultant. Geotextile overlaps at panel intersections and odd corner seams may be heat bonded at the discretion of the Owner's Representative or CQA Consultant.

E. Completed GDN seams shall lay flat and be free of any rocks, loose soil, or other debris. Where wrinkles or folds do occur, the material shall be cut, overlapped, and a patch applied in accordance with Part 3.06 of this Section.

3.06 Repairs

A. During installation, GDN Installer and CQA Consultant shall visually inspect all GDN panels and seams for damage, defects, or non-compliance with the Drawings and Specifications, and shall mark any such areas for repair. GDN Installer shall repair marked areas as soon as possible and prior to covering the GDN.

B. Acceptable GDN repair methods include:

   1. Patching: For repair of surface defects, small tears, punctures, etc. Patches shall have a minimum size of 24 inches by 24 inches and extend at least 12 inches beyond the edge(s) of a defect. Patches shall be secured to original GDN using plastic ties placed at minimum 6-inch spacing around the patch. Geotextile shall be heat bonded over the edges of the patch as described in Part 3.05 of this Section.

C. If an area to be repaired is more than 50 percent of the width of a GDN panel, the damaged area shall be removed across the entire panel width and the two remaining portions of GDN shall be joined in accordance with Part 3.05 of this Section. Such repair areas shall be explicitly approved by the CQA Consultant prior to making the repair.

3.07 Acceptance and Covering

A. No GDN shall be covered until it has been accepted by the CQA Consultant in writing.

B. GDN Installer shall repair any areas identified by the CQA Consultant as not being in accordance with the Drawings and Specifications. Once all repairs are completed and accepted by the CQA Consultant, GDN shall immediately be covered in accordance with the Drawings and Specifications.

C. All GDN panels shall be covered with cover soils within 2 weeks after they are placed to prevent deterioration of the upper geotextile. Any GDN that deteriorates or is otherwise damaged prior to placement of covering material shall be removed and replaced by the GDN Installer, as directed by the CQA Consultant, at no cost to Owner.

D. If textured geomembrane is used below the GDN, a smooth temporary geosynthetic covering ("slip sheet") shall be used to protect the lower surface of the GDN from damage until the geomembrane is in its final position for seaming.

3.08 Warranties

A. Contractor shall be responsible for obtaining any necessary guarantees or certifications from the GDN Manufacturer and GDN Installer and submitting them to the Owner's Representative and Owner prior to acceptance of installed GDN.

B. Contractor shall guarantee the integrity, within the realm of limitations of Contractor's responsibility, of the installed GDN for its intended use, from installation defects for a period of 2 years from the date of GDN installation, and from manufacturing defects for a period of 5 years from the date of GDN installation. Such written warranties shall provide for the total and complete repair and/or replacement of any defect or defective areas of GDN upon written notification and demonstration by the Owner of the specific non-conformance of the GDN or installation with the Drawings and Specifications. Such defects or non-conformance shall be repaired and/or replaced expeditiously, at no cost to Owner.

Table 1
Required Properties of GDN(1)

Property (Units)	MQC Testing Frequency (Minimum)	Test Method(2)	Required Value
HDPE Geonet Resin			
Density (g/cc)	1 per Resin Batch	ASTM D 1505 or D 792	0.940 (min)
Melt Flow Index (g/10 mins)	1 per Resin Batch	ASTM D 1238, Condition 190/2.16	1.0 (max)
Finished HDPE Geonet(3)			
Density, (g/cc)	Every 50,000 ft^2	ASTM D 1505 or D 792	0.940 (min ave)
Thickness (mil)	Every 50,000 ft^2	ASTM D 5199	270±15 (range)(4)
Carbon Black Content (%)	Every 50,000 ft^2	ASTM D 4218	2.0 - 3.0 (range)
Finished Nonwoven PP Geotextile(3)			
Mass per unit Area (oz./$yd.^2$)	Every 100,000 ft^2	ASTM D 5261	8.0 (MARV)
Grab Tensile Strength (lb)	Every 100,000 ft^2	ASTM D 4632	203 (MARV)
Tear Strength (lb)	Every 100,000 ft^2	ASTM D 4533	79 (MARV)
Puncture Strength (lb)	Every 100,000 ft^2	ASTM D 6241	650 (MARV)
Permittivity (sec^{-1})	Every 500,000 ft^2	ASTM D 4491	1.26 (MARV)
Apparent Opening Size (mm)	Every 500,000 ft^2	ASTM D 4751	0.18 (MaxARV)
UV Stability (percent strength retained at 500 hours)	Per Formulation	ASTM D 4355	70 (min)
Finished GDN			
100-hr Transmissivity (m^2/sec)	Every 500,000 ft^2	ASTM D 4716	4.1×10^{-4} (MARV)(4)
Ply Adhesion (lb/in)	Every 15,000 ft^2	ASTM D7005	1.0 (MARV)(5)

Notes:

(1) The required properties specified herein may be revised by the Engineer to reflect new or revised test methods or to conform with improvements to the state-of-the practice.

(2) Number of specimens per test established in applicable test method unless otherwise noted.

(3) Perform tests on material before incorporation into finished GDN.

(4) Perform test using rigid platen for substrate and Protective Cover Soil compacted per Owner's Engineer requirements for the superstratum. Test conditions: Normal stress = 300 pounds per square foot; Hydraulic gradient = 0.25; Seating period = 100 hours.

(5) Average of five equally spaced tests across the roll width. Lowest individual value = 0.5-pound per inch (lb/in).

Table 2
Interface Shear Strength Requirements for GDN(1, 2, 3, 4)

<table>
<tr><th colspan="3">Testing Set-Up</th></tr>
<tr><td rowspan="4">Standard Test</td><td>Conditioning and Set-up:</td><td>Set up each test to match field placement orientation. Run all tests under wet conditions.</td></tr>
<tr><td>Procedure A:</td><td>GDN against Geomembrane
Substrate: Project Textured 40 Mil LLDPE Geomembrane
Superstratum: Project GDN
Displacement Rate: 0.04-ipm (maximum)
Total Displacement: 2.5 inches (minimum)</td></tr>
<tr><td>Procedure B:</td><td>GDN against Site Protective Cover Soil
Substrate: Project GDN
Superstratum: Site Protective cover soil soil at 90% Standard Proctor MDD ± 3% OMC
Displacement Rate: 0.04-ipm (maximum)
Total Displacement: 2.5 inches (minimum)</td></tr>
<tr><td>Special Instructions:</td><td>None.</td></tr>
<tr><th colspan="2" rowspan="2">Normal Load [Pounds per Square Foot (psf)]</th><th>Standard Test</th></tr>
<tr><th>Peak Shear Strength</th></tr>
<tr><td colspan="2">150</td><td rowspan="4">20 Degrees</td></tr>
<tr><td colspan="2">300</td></tr>
<tr><td colspan="2">600</td></tr>
<tr><td colspan="2">1000</td></tr>
</table>

Notes:

(1) Testing to be performed in accordance with ASTM D 5321 utilizing the test conditions and procedures outlined in Table 2. GDN is not acceptable if geotextile delaminates from the geonet, even if required strengths are attained. Test frequency as per the CQA Plan.

(2) Test individual interfaces between Steel rasp platens. In lieu of testing individual interfaces, a system test may be performed using configuration that allows failure to occur through the weakest shearing plane. System test configuration, conditions, and procedures must be accepted by the Engineer prior to submitting test results for review and approval.

(3) Interfaces shall be saturated for a minimum of 24 hours prior to testing.

(4) Geosynthetics shall be oriented such that the shear force is parallel to the down slope orientation of these components in the field.

-End of Section-

SECTION 02595
Geotextiles

Section 02595
Geotextiles

Part 1 General

1.01 Summary

A. This section includes the technical requirements for materials and installation of geotextiles.

1.02 References

The following codes and standards are referenced in this section:

A. ASTM International (ASTM) Standards:

1. D 3786, "Test Method for Bursting Strength of Fabrics: Diaphragm Bursting Strength Tester Method".
2. D 4355, "Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture, and Heat in a Xenon-Arc Type Apparatus".
3. D 4533, "Test Method for Trapezoidal Tearing Strength of Geotextiles".
4. D 4632, "Test Method for Grab Breaking Load and Elongation of Geotextiles".
5. D 4751, "Test Method for Determining Apparent Opening Size of a Geotextile."
6. D 4833, "Test Method for Index Puncture Resistance of Geomembranes and Related Products".
7. D 5261, "Standard Test Method for Measuring Mass per Unit Area of Geotextiles".
8. D 5321, "Test Method for Determining the Shear Strength of Soil-Geosynthetic and Geosynthetic-Geosynthetic Interfaces by Direct Shear".

B. Geosynthetic Research Institute (GRI):

1. Guide GS11, "Standard Guide for Constructing Test Pads to Assess Protection Materials Intended to Avoid Geomembrane Puncture."

1.03 Definitions

A. Minimum Average Roll Value (MARV): For geosynthetics, the mean value minus two standard deviations calculated from documented quality control test results for a defined population for one specific test method associated with one specific property.

B. Maximum Average Roll Value (MaxARV): For geosynthetics, the mean value plus two standard deviations calculated from documented quality control test results for a defined population for one specific test method associated with one specific property.

Part 2 Products

2.01 Geotextile

A. The geotextiles shall be geotextile made up of polypropylene (PP) filaments. The physical, mechanical, and chemical properties of the geotextile shall comply with the requirements of this Section. During production, geotextile shall be continuously inspected for the presence of broken needles, which shall be removed from the finished product. The use of woven slit film geotextiles (i.e. geotextiles made from yarns of flat, tape-like character) and heat calendared nonwoven geotextiles will not be allowed.

B. Geotextile formulations shall consist of at least 95 percent (by weight) PP resin. No plasticizers, fillers, extenders, post-consumer resin, or other materials shall be mixed into the formulation. Rework or trim materials may be added to the formulation if they are produced by the Geotextile Manufacturer and are of the same formulation as the geotextile being produced. Rework and trim materials shall not exceed 10 percent (by weight) of the geotextile formulation.

C. PP resin used in the manufacture of nonwoven geotextile is to be made from virgin, uncontaminated ingredients and shall be designed and manufactured specifically for producing geotextile. Incoming resin shall be sampled and tested in accordance with the Geotextile Manufacturer's manufacturing quality control program. Testing frequencies, test procedures, and resin properties shall comply with the requirements of this Section. Results from the resin sampling and testing program are to be submitted to the Engineer.

D. The hybrid monolithic woven-nonwoven needle-punched underdrain geotextile meeting the requirements of Table 4. Qualified materials shall be the top (hybrid) geotextile from CoalDrain 300 mil Geocomposite as manufactured by GSE or equal as approved by the Owner's Representative.

E. Where applicable, Tables 1a, 2, 3, and 4 property values represent the MARV in the weakest principal directions. Except where noted otherwise, values for AOS represent the minimum values and corresponding 95 percent opening size (O_{95}) represents the MaxARV.

2.02 Material Requirements

Table 1a
Minimum Physical Requirements for Cushion Geotextile(1)

Property	Test Method	Criteria
Weight	ASTM D 5261	12 oz./sq. yd. minimum
Grab Tensile Strength	ASTM D 4632	300 pounds (lbs)
Grab Elongation	ASTM D 4632	50 percent
Trapezoid Tear Strength	ASTM D 4533 (in machine and cross-machine directions)	115 lbs
Puncture Strength	ASTM D 6241	800 lbs
UV Stability (percent strength retained at 500 hours)	ASTM D 4355	70 (minimum)
Minimum Interface Shear Strength	ASTM D 5321	See Table 2-2 of the Linear Low Density Polyethylene Specification

Note:

(1) Nonwoven.

Table 1b
Interface Shear Strength Requirements for Cushion Geotextile (1, 2)

Testing Set-Up		
ASTM D5321	Conditioning:	Set up each test to match field placement orientation. Run all tests under wet conditions.
	Procedure A:	Cushion Geotextile against Prepared Subgrade Substrate: Prepared Subgrade Soil Compacted Simulating Field Conditions Superstratum: Project Cushion Geotextile Displacement Rate: 0.04 ipm (maximum) Total Displacement: 2.50 in (minimum)
	Special Instructions:	None.

Strength Requirements	
Normal Stress [Pounds per Square Foot (psf)]	**Minimum Peak Shear Strength**
150	20 degrees
300	
600	
1000	

Notes:

(1) Test individual interfaces between Steel rasp platens. In lieu of testing individual interfaces, a system test may be performed using a configuration that allows failure to occur through the weakest shearing plane. System test configuration, conditions, and procedures must be accepted by the Engineer prior to submitting test results for review and approval.

(2) Test frequency as per CQA Plan.

Table 2
Minimum Physical Requirements for Separation Geotextile (1)

Property	Test Method	Criteria
Weight(Typical)	ASTM D5261	12.0 oz/sy
Grab Tensile Strength	ASTM D 4632	315 lbs.
Grab Elongation	ASTM D 4632	50 percent
CBR Puncture Resistance	ASTM D6241	850 lb
Tear Strength	ASTM D 4533	115 lbs
Permittivity	ASTM D4491	0.9 sec-1
Water Flow	ASTM D4491	70 gpm/ft^2
Apparent Opening Size	ASTM D 4751	0.150 mm (maxARV)
UV Stability (percent strength retained at 500 hours)	ASTM D 4355	50 (minimum)

Note:

(1) Nonwoven.

Table 3
Physical Requirements for Nonwoven Filter Geotextile

Property	Test Method	Criteria
Mass per unit Area (oz./yd.^{2})	ASTM D 5261	8.0 (MARV)
Grab Tensile Strength (lb)	ASTM D 4632	205 (MARV)
Tear Strength (lb)	ASTM D 4533	85 (MARV)
Puncture Strength (lb)	ASTM D 6241	535 (MARV)
Permittivity (sec^{-1})	ASTM D 4491	1.3 (MARV)
Apparent Opening Size (mm)	ASTM D 4751	0.18 (MaxARV)
UV Stability (percent strength retained at 500 hours)	ASTM D 4355	70 (min)

Table 4
Required Properties of Underdrain Geotextile

Property (Units)	MQC Testing Frequency (Minimum)	Test Method	Required Value
Composite Geotextile[2]			
Structure	Hybrid Monolithic Woven-Nonwoven Needlepunched		
Mass per unit Area (oz./yd.^{2})	Every 100,000 ft^2	ASTM D 5261	14 (MARV)
Grab Tensile Strength (lb)	Every 100,000 ft^2	ASTM D 4632	200 (MARV)
Tear Strength (lb)	Every 100,000 ft^2	ASTM D 4533	85 (MARV)
Puncture Strength (lb)	Every 100,000 ft^2	ASTM D 6241	775 (MARV)
Permittivity (sec^{-1})	Every 500,000 ft^2	ASTM D 4491	0.3 (MARV)
Apparent Opening Size (mm)	Every 500,000 ft^2	ASTM D 4751	0.088 (MaxARV)
UV Resistance, % retained	Per Formulation	ASTM D 4355	70 (typical)
Typical Roll Dimensions (3)			
Roll Width, ft			15.0
Roll Length, ft			160

Note:

(1) Roll widths and lengths have a tolerance of ±1%.Part 3Execution

3.01 Geotextile Installation

A. During all periods of shipment and storage, the geotextile shall be protected from direct sunlight, ultraviolet rays, and temperatures greater than 140 degrees Fahrenheit. To the extent possible, the geotextile shall be maintained wrapped in its protective covering. The geotextile shall not be exposed to sunlight, ultraviolet rays until the installation process begins.

B. Cushion Geotextile shall only be placed on the Prepared Subgrade surface that has been installed in accordance with the Drawings and Specifications, and has been accepted in writing by the Contractor, Geotextile Installer, Geomembrane Installer, and Owner's Representative. Once Prepared Subgrade surface has been accepted by the Owner's Representative, any additional surface preparation that the Contractor, Geotextile Installer, or Geomembrane Installer feels necessary to meet the requirements of the Specifications shall be the responsibility of the Contractor. Cushion geotextile may be omitted if approved in writing by the Owner's Engineer and the subgrade particles protrude less than 3/8 inch. Maximum allowable protrusions beneath specified Cushion Geotextile will be as determined by the Owner's Engineer and may be determined by a test pad in accordance with GRI GS11.

C. Prepared Subgrade surface shall be free of dirt, tools, or other debris before placing Cushion Geotextile or Geomembrane. Areas the Geotextile Installer or Geomembrane Installer believes exhibit deficient subgrade conditions shall be reported to the Owner's Representative and Owner for repair.

D. Filter, Underdrain, and Separation Geotextiles shall be placed as indicated on the Drawings.

E. On slopes, the geotextiles shall be securely anchored and then rolled down the slope in such a manner as to continually keep the geotextile in tension.

F. In the presence of wind, all geotextiles shall be weighted with sandbags or the equivalent. Sandbags shall be installed during placement and shall remain until replaced with protective cover soils.

G. Geotextiles shall be kept continually under slight tension to minimize the presence of wrinkles in the geotextile.

H. Geotextiles shall be cut using an approved geotextile cutter only. If in place, special care shall be taken to protect other materials from damage which could be caused by the cutting of the geotextiles.

I. The Installer shall take any necessary precautions to prevent damage to the underlying geomembrane during placement of the geotextile.

J. During placement of geotextiles, care shall be taken not to entrap in the geotextile: stones, excessive dust, or moisture that could damage the underlying geomembrane, or hamper subsequent seaming.

K. If white-colored geotextile is used, precautions shall be taken against "snow blindness" of personnel.

L. Horizontal seams shall be minimized as much as practical, except as part of a patch. The Contractor shall pay particular attention at seams so that no material could be inadvertently inserted beneath the geotextiles.

M. Continuously overlap cushion geotextile panels a minimum of 12 inches at all longitudinal and transverse joints. Continuously overlap nonwoven filter geotextile panels a minimum of 18 inches at all longitudinal and transverse joints. If approved, sewn seams may be used for cushion and nonwoven geotextiles instead of overlapped seams. If sewn, cushion and nonwoven filter geotextiles shall be continuously sewn together with two rows of Type 401 stitching (field-stitch). Geotextiles shall be overlapped at a minimum of 6 inches prior to seaming. Sewing shall be done using thread made from the same type of polymer as the geotextile being sewn together. Sewing thread should be a color that contrasts the geotextile color. Thermal seaming methods may be accepted if successfully demonstrated in the field and approved by the Engineer and Owner's Representative.

N. Continuously overlap separation geotextile panels beneath riprap a minimum of 24 inches at all longitudinal and transverse joints, and continuously overlap separation geotextile panels beneath other materials a minimum of 18 inches at all longitudinal and transverse joints

O. Continuously overlap underdrain geotextile panels a minimum of 18 inches across the top of the trench and a minimum of 3 feet for end-to-end panels.

P. Extreme care shall be taken by all personnel while handling, unwrapping, deploying, and placing geotextile. Equipment and tools used shall not stretch, tear, or otherwise damage the geotextile, and shall not cause damage to the underlying geomembrane. Equipment shall have sufficient capacity to manage the roll weight without damaging the geotextile. Geotextile shall only be handled and deployed using a stinger or spreader bar assembly recommended by the Geotextile Manufacturer or acceptable to the Owner's Representative. Pushing, sliding, or dragging of geotextile rolls is not permitted.

Q. Under no circumstances shall any construction or vehicular traffic be allowed to drive over exposed geotextile. Geotextile showing evidence of trafficking shall be inspected by the Geotextile Installer, Contractor, and Owner's Representative to evaluate damage, if any. At the direction of the Owner's Representative, any damaged geotextile shall be repaired or replaced. Owner's representative may allow limited use of four-wheeled all-terrain vehicles or other low ground pressure equipment (having 6 pounds per square inch or less contact pressure) by the Geotextile Installer during installation, but use shall be prohibited if excessive trafficking or any geotextile damage is observed.

R. Geotextile Installer shall immediately provide temporary anchorage of the geotextile to prevent wind uplift and panel movement during placement of covering materials. No permanent bonding of geotextile to geomembrane shall be permitted. Temporary anchorage methods shall be approved by the Engineer and Owner's Representative. If bags are used for temporary anchorage, they shall be filled with aggregate, soil or fine-grained sand that has been approved for use by the Owner's Representative. Any geotextile exhibiting damage due to insufficient or improper temporary anchorage shall be repaired or replaced, as directed by the Owner's Representative.

S. Geotextile panel seams (edges) shall be oriented in a direction parallel to the line of maximum subgrade slope (i.e., down, not across the slope) and shall be placed in a manner that minimizes the number and length of field seams.

T. Where separation geotextile is used in channel linings, all folds and wrinkles should be removed from the geotextile before the channel lining is placed on top of it. Place the geotextile so that there is sufficient overlap to seal the seams for intrusion of water and ensure minimal stretch of the geotextile material. Upstream strips of material must overlap the downstream strips and upslope strips overlap downslope strips.

U. All geotextile panel seams parallel to the toe of a slope ("longitudinal seams") shall be located at least 5 feet from the toe of the slope, except where explicitly approved by the Owner's Representative. Longitudinal seams are permitted on side slopes, but must be staggered in a manner approved by the Engineer and Owner's Representative.

V. Underdrain geotextile shall be placed in pond ash, **with the nonwoven side of the hybrid geotextile placed against the ash**. Underdrain geotextile shall be installed at locations necessary for construction dewatering and approved by the Owner's Representative. All placement of Underdrain geotextile and associated aggregate and piping shall be observed by the CQA Consultant. Underdrain geotextile installation shall be approved by the CQA Consultant prior to installation of the associated underdrain aggregate and piping.

3.02 Repairs

A. During installation, Geotextile Installer and Owner's Representative shall visually inspect all geotextile panels and seams for damage, defects, or non-compliance with the Drawings and Specifications, and shall mark any such areas for repair. Geotextile Installer shall repair marked areas as soon as possible and prior to covering the geotextile with the drainage layer material.

B. Acceptable geotextile repair methods include:

1. Patching: For repair of surface defects, small tears, punctures, etc. Patches shall have a minimum size of 24 inches by 24 inches and extend at least 12 inches beyond the edge(s) of a defect. Patches shall be secured to original geotextile using adhesive or by hot-air bonding ("leistering") around the patch.

C. If an area to be repaired is more than 50 percent of the width of a geotextile panel, the damaged area shall be removed across the entire panel width and the two remaining portions of geotextile shall be joined in accordance with this Section. Such repair areas shall be explicitly approved by the Owner's Representative prior to making the repair.

3.03 Final Inspection, Acceptance, and Covering

A. No geotextile shall be covered until it has been accepted by the Owner's Representative in writing.

B. Geotextile Installer shall repair any areas identified by the owner's Representative as not being in accordance with the Drawings and Specifications. Once all repairs are completed and accepted by the Owner's Representative, geotextile shall immediately be covered in accordance with the Drawings and Specifications.

C. All geotextile panels shall be covered within 2 weeks after they are placed to prevent deterioration of the geotextile. Any geotextile that deteriorates or is otherwise damaged prior to placement of covering shall be removed and replaced by the Geotextile Installer, as directed by the Owner's Representative, at no cost to the Owner.

-End of Section-

SECTION 02597
Linear Low Density Polyethylene Geomembrane

Section 02597
Linear Low Density Polyethylene Geomembrane

Part 1 General

1.01 Summary

A. Contractor shall furnish all supervision, labor, products, equipment, and tools, including all necessary and incidental items as detailed or required, to install geomembrane in accordance with the Drawings, Specifications, and project Construction Quality Assurance (CQA) Plan.

1.02 References

A. ASTM International (ASTM) Standards:

1. D 792, "Standard Test Method for Density and Specific Gravity (Relative Density) of Plastics by Displacement".
2. D 1004, "Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting".
3. D 1238, "Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer".
4. D 1505, "Standard Test Method for Density of Plastics by the Density-Gradient Technique".
5. D 1603, "Standard Test Method for Carbon Black in Olefin Plastics".
6. D 3895, "Standard Test Method for Oxidative Induction Time of Polyolefins by Differential Scanning Calorimetry".
7. D 4218, "Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique".
8. D 4833, "Test Method for Index Puncture Resistance of Geomembranes and Related Products".
9. D 5321, "Standard Test Method for Determining the Strength of Soil-Geosynthetic and Geosynthetic Interfaces by Direct Shear".
10. D 5596, "Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics".
11. D 5885, "Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High Pressure Differential Scanning Calorimetry".
12. D 5994, "Test Method for Measuring the Core Thickness of Textured Geomembranes".
13. D 6392, "Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods".
14. D 6693, "Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes".

15. D 7466, "Standard Test Method for Measuring the Asperity Height of Textured Geomembrane".

B. Geosynthetic Research Institute (GRI) Standards:

1. GRI Test Method GM 17, "Test Methods, Test Properties and Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes".

1.03 Definitions

A. Formulation: The mixture of a unique combination of ingredients identified by type, properties, and quantity. For LLDPE geomembrane, a formulation is defined as the exact percentages and types of resin(s), additives, and carbon black.

1.04 Submittals

A. Contractor shall be responsible for timely submittals to the Engineer and Owner.

B. The following submittals shall be provided:

1. The geomembrane and Geomembrane Manufacturer must be approved by the Engineer and Owner prior to Contract award. Submittals for approval include:

   a. Geomembrane Manufacturer's specification sheet(s) demonstrating compliance with the requirements of Table 1 of this Section.

   b. Written certification that the Geomembrane Manufacturer has produced a minimum of 10,000,000 square feet of LLDPE geomembrane that has been installed for hydraulic containment purposes in the last 2 years, including a list of the relevant completed facilities. Each entry in this list should include the name, location, and purpose of the facility; geomembrane thickness, total square footage, and date of installation. Names of the Owner, Designer, Fabricator (if any), and Geomembrane Installer; and the name and telephone number of a contact at the facility who can discuss the project shall be provided upon request.

   c. A copy of the Geomembrane Manufacturer's manufacturing quality control (MQC) manual. This manual should describe the quality control program(s) for formulation ingredients (raw materials), finished geomembrane sheet, and extrudate rod, and indicate the properties, test methods, and testing frequencies used for each. Geomembrane Manufacturer shall modify the MQC manual to comply with the requirements of these Specifications, with any variations, deviations, or exceptions clearly noted in an attached letter.

2. The geomembrane shall meet the interface shear strength requirements of Table 2 of this Section. Interface shear strength testing to verify compliance with the requirements of Table 2 shall be performed by the Owner as noted in Part 3.03 of this section. However, the Geomembrane Manufacturer shall review the interface shear strength requirements and test procedures outlined in Table 2 to avoid proposing the use of a geomembrane product(s) that will not meet these requirements. The interfaces that exist for this project include:

   a. Geomembrane against Prepared Subgrade.

   b. Geomembrane against cushion geotextile.

   c. Geocomposite drainage net (GDN).

3. The Geomembrane Installer must be approved by the Engineer and Owner prior to Contract award. Submittals for approval include:
   a. Written certification that the Geomembrane Installer has installed a minimum of 10,000,000 square feet of LLDPE and/or high density polyethylene (HDPE) geomembrane for hydraulic containment purposes in the last 4 years, including a list of the relevant completed facilities. Each entry in this list should include the name, location, and purpose of the facility; geomembrane thickness, total square footage, and date of installation; names of the Owner, Designer, Primary Contractor, and CQA Consultant; and the name and telephone number of a contact at the facility who can discuss the project.
   b. A copy of the Geomembrane Installer's CQA manual. This manual should describe the quality control programs for handling, deploying, placing, anchoring, seaming, repairing, and testing geomembrane. Geomembrane Installer shall modify the CQA manual to comply with the requirements of these Specifications and the project CQA Plan, with any variations, deviations, or exceptions clearly noted in an attached letter.

C. The following submittals shall be provided after award of Contract:
1. Geomembrane Manufacturer:
   a. Prior to or coincident with shipment of geomembrane to the project site, submit written certification and supporting test data documenting that all resin used for geomembrane production complies with the requirements of Part 2.01.D of this Section. This certification shall state the producer, product designation, lot or batch number, and production date of all resin used in the manufacture of geomembrane shipped to the project site and shall include copies of all quality control certificates issued by the resin producer.
   b. Prior to or coincident with shipment of geomembrane to the project site, submit written certification stating that the geomembrane and extrudate rod shipped to the project site were produced using the same resin. Include supporting test data documenting that extrudate rod complies with the requirements of Part 2.02.B of this Section.
   c. Prior to or coincident with shipment of geomembrane to the project site, submit written certification stating that all formulations used to produce geomembrane shipped to the project site comply with the requirements of Part 2.01.
   d. Prior to or coincident with shipment of geomembrane to the project site, submit written certification and supporting test data, in the form of Quality Control Certificates, documenting that all geomembrane shipped to the project site complies with the requirements of Part 2.01 of this Section. Geomembrane Quality Control Certificates must be reviewed and signed by a responsible representative of the Geomembrane Manufacturer.
2. Geomembrane Installer:
   a. Two months prior to shipment of geomembrane to the project site, submit six full sets of field installation drawings for Engineer's approval.

Installation drawings shall show the proposed length, width, and position of all geomembrane panels and the location of all field seams.

Geomembrane panels and field seams shall have distinct identification systems. Panel layouts shall avoid field seams that are parallel to and fall within pipe trenches or envelopes. Installation drawings shall also show complete details for field seaming and repairs, anchoring geomembrane at the perimeter of the installation area, and attachments to structures and other penetrations, as required.

b. Two weeks prior to arrival at the project site, submit personnel resumes demonstrating compliance with the following:

   1) A minimum of one field superintendent per shift shall be designated by the Geomembrane Installer and approved by the Engineer and Owner. Each field superintendent shall have a minimum of 5 years of field experience installing LLDPE and/or HDPE geomembrane. Any change or replacement of superintendents during the project must be approved in advance by the Engineer and Owner.

   2) Each seaming crew shall have a designated foreman. Said foreman must have a minimum of 2 years of LLDPE and/or HDPE geomembrane installation experience and must work continuously with the seaming crew.

   3) Each welding technician shall have a minimum of 1,000,000 square feet of LLDPE and/or HDPE geomembrane welding experience.

c. Within 4 weeks after completion of geomembrane installation, submit a written report containing the following:

   1) Written certification stating that the geomembrane has been installed in accordance with the Drawings, Specifications, and project CQA Plan.

   2) Product and installation warranties as required by Part 3.09 of this Section.

   3) Copies of daily field records and all testing documentation (trial seam testing, non-destructive testing, etc.).

   4) As-built drawings depicting actual geomembrane panel placement and all associated details. As-built geomembrane plans ("panel diagrams") shall be prepared at a reasonable Engineer's scale using Contractor's surveyed edge of geomembrane limits (anchor trenches, runouts, etc.), and shall accurately depict panel orientations and dimensions; all repair locations (patches, cap strips, etc.); and shall clearly identify all panel numbers, seam identification numbers, and destructive testing sample locations.

1.05 Construction Quality Assurance

A. Geomembrane CQA will be performed by the Owner's Representative.

B. Geomembrane CQA will be performed in accordance with these Specifications and the project CQA Plan.

Part 2 Products

2.01 LLDPE Geomembrane

A. The geomembrane and Geomembrane Manufacturer must be approved by the Engineer and Owner prior to Contract award, as required by Part 1.04B.1 of this Section.

B. Geomembrane shall be 40 mil LLDPE having textured upper and lower sheet surfaces. The physical, mechanical, and chemical properties of the geomembrane shall comply with the requirements of Table 1 of this Section. Textured geomembrane having smooth edge strips 6 to 8 inches in width (to facilitate field seaming) may be acceptable if the base geomembrane complies with the requirements of Table 1 of this Section and the texturing material is of the same type of polymer and formulation as the base geomembrane.

C. Geomembrane formulation shall consist of at least 97 percent (by weight) polyethylene resin, 2 percent to 3 percent (by weight) of carbon black [added for ultraviolet (UV) radiation resistance], and a maximum of 1 percent (by weight) of other additives. No plasticizers, extenders, post-consumer resin, or other materials shall be mixed into the formulation. Regrind, rework, or trim materials may be added to the formulation if they are produced by the Geomembrane Manufacturer and are of the same formulation as the geomembrane being produced. Regrind, rework, and trim materials shall not exceed 10 percent (by weight) of the geomembrane formulation.

D. Polyethylene resin used in the manufacture of geomembrane is to be made from virgin, uncontaminated ingredients and shall be designed and manufactured specifically for producing geomembrane. Incoming resin shall be sampled and tested in accordance with the Geomembrane Manufacturer's approved MQC manual. Testing frequencies, test procedures, and resin properties shall comply with the requirements of Table 1 of this Section. Results from the resin sampling and testing program are to be submitted to the Engineer in accordance with Part 1.04.C.1.a of this Section.

E. During production, finished geomembrane sheet shall be sampled and tested in accordance with the Geomembrane Manufacturer's approved MQC manual. Testing frequencies, test procedures, and finished sheet properties shall comply with the requirements of Table 1 of this Section. Results from the finished sheet sampling and testing program, in the form of Quality Control Certificates, are to be submitted to the Engineer in accordance with Part 1.04.C.1.d of this Section.

F. Geomembrane shall be produced free of holes, bubbles, blisters, scratches, undispersed raw materials, contamination by foreign matter, dimensional abnormalities, or other defects. Textured geomembrane shall generally have a uniform texturing appearance and be free from agglomerated texturing material. The Owner's Representative may reject all or portions of units (rolls) of geomembrane shipped to the project site if significant production flaws are observed.

G. Geomembrane shall be manufactured as a continuous sheet having a minimum width of 20 feet and minimum length of 500 feet in order to reduce the amount of field seaming required during installation. No factory seaming of LLDPE geomembrane panels shall be accepted.

H. Geomembrane shall be rolled onto hollow cores having a minimum outside diameter of 6 inches and an inside diameter large enough to allow the use of a spreader bar assembly or fork lift stinger for handling and deployment. Cores shall be of stable construction such that they support the roll without excessively deflecting, buckling, or otherwise failing during handling, transportation, and storage. Rolled geomembrane shall be secured using dedicated straps, slings, or other suitable means to facilitate handling.

I. Each geomembrane roll shall be marked or labeled to identify the Geomembrane Manufacturer, product designation, manufacturer's lot number, manufacturer's roll number, sheet thickness, length and width of each roll, and panel number (if applicable). Roll identification numbers shall conform to the numbering system established on the Geomembrane Manufacturer's Quality Control Certificates. Labels or markings shall be legible and located so that each roll of geomembrane can be identified by examining the outside of the roll or the core ends. Markings or labels shall be weather proof.

J. At the option of the Owner, the Engineer may inspect the geomembrane manufacturing process on a full-time basis. This inspection program would include conformance sampling as required. If requested, Geomembrane Manufacturer shall submit a production schedule to the Owner and cooperate with the Engineer during plant inspection.

K. All raw material and finished geomembrane properties, including testing frequencies and test procedures used, shall meet the requirements of this Section. No geomembrane shall be installed until the Engineer has reviewed all certifications and supporting test data and determined that the geomembrane delivered to the project site is acceptable for use. Manufacturing records, including test data, shall be maintained by the Geomembrane Manufacturer for 2 years after acceptance of the geomembrane, and shall be made available upon request.

2.02 LLDPE Extrudate Rod

A. Extrudate rod to be used for all extrusion seaming of the geomembrane shall be made from the same resin as the geomembrane and shall be free of contamination by moisture or other materials. Carbon black and additives shall be thoroughly dispersed throughout the extrudate rod.

B. Extrudate rod resin and finished rod shall be sampled and tested in accordance with the Geomembrane Manufacturer's approved MQC manual. Extrudate rod resin shall meet the LLDPE geomembrane resin requirements of Table 1 of this Section. Finished extrudate rod shall meet the LLDPE geomembrane carbon black content and carbon black dispersion requirements of Table 1 of this Section. Testing frequencies and test procedures shall comply with the requirements of Table 1, as applicable. Results from the extrudate rod sampling and testing program are to be submitted to the Engineer in accordance with Part 1.04.C.1.b of this Section.

2.03 Pipe Penetration Seals

A. Boots (sleeves and skirts) to be used for sealing all pipe penetrations in the geomembrane shall be smooth 40 mil LLDPE meeting the physical, mechanical, and chemical properties of Table 1 and the formulation and resin requirements of Part 2.01 of this Section. Factory pre-fabricated boots, produced by either the Geomembrane Manufacturer or Geomembrane Installer, are preferred for this project.

B. Gaskets to be used for sealing boots to pipes penetrating the geomembrane shall be neoprene and meet the dimensional requirements shown on the Drawings. Neoprene adhesive shall be in accordance with the Geomembrane Manufacturer's requirements.

C. Banding clamps to be used to attach boots to pipes penetrating the geomembrane shall be stainless steel and meet the dimensional requirements shown on the Drawings.

Part 3 Execution

3.01 Pre-Installation Meeting

A. Prior to scheduled geomembrane installation, the Owner, Owner's Representative, and Geomembrane Installer shall attend a pre-installation meeting at the project site; Virginia Department of Environmental Quality will be notified when this meeting will be held. This meeting shall be scheduled by the Owner after receipt of Geomembrane Installer's field installation drawings.

B. Geomembrane Installer shall be represented by both the project field superintendent and the project manager.

C. At the pre-installation meeting, site safety and rules of operation, scheduling, methods of installation, and CQA shall be discussed. The Geomembrane Installer, Owner, and Owner's Representative shall at this time agree to the required geomembrane placement, seaming, sampling, testing and repair procedures for the project.

3.02 Shipping, Handling, and Storage

A. Contractor is responsible for proper shipping, unloading, and storage of the geomembrane. Geomembrane damaged during shipping, unloading, or storage shall be repaired or replaced at no cost to the Owner.

B. Geomembrane rolls shall be packaged and shipped so that no damage is caused during delivery to the project site. Geomembrane shipping shall be by open trailer so rolls can be readily unloaded at the project site by lifting directly from the trailer using slings/straps, a stinger, or a spreader bar assembly.

C. During unloading at the project site, Contractor and Owner's Representative shall conduct a surface inspection of all geomembrane rolls for defects and damage.

D. Extreme care shall be taken by all personnel while unloading and handling geomembrane. Equipment used to unload and handle geomembrane shall have sufficient capacity to manage the roll weight without damaging the geomembrane. Geomembrane shall only be unloaded and handled using a stinger, spreader bar assembly, or the straps/slings provided by the Geomembrane Manufacturer. Pushing, sliding, or dragging of geomembrane rolls is not permitted. Owner's Representative shall have the option of inspecting all geomembrane panels, prior to final placement, to verify that all defects or damage are identified for repair.

E. Geomembrane shall be stored at the project site in an area(s) designated by the Owner and accepted by the Owner's Representative. Contractor shall grade the storage area so that it is reasonably level and well-drained, and shall prepare the ground surface so that it is firm, smooth, and free of stones, sticks, or other materials that may damage the geomembrane.

F. Stacking of geomembrane rolls for storage is allowed but should not be so high that crushing of cores or flattening of rolls occurs. In general, the maximum stacking limit is three rolls high. A suitable means of securing the rolls shall be used so that shifting, abrasion, or other adverse movement does not occur. Geomembrane with folds or creases of any kind shall be rejected and removed from the project site.

G. During storage, geomembrane shall be protected from excessive dust and mud by covering the rolls with a plastic sheet or waterproof tarpaulin. Roll labels shall remain intact and legible. Any roll of geomembrane that has no label or where the label is damaged or otherwise illegible may be rejected by the Owner's Representative.

3.03 Quality Control Conformance Testing

A. Quality control conformance testing of the geomembrane shall be performed by the Owner's Representative at the frequencies shown in Table 1 of this Section. Conformance sampling and testing shall be completed in accordance with the project CQA Plan, with at least one sample per production lot as directed by the Engineer. A production lot is defined as a single run of geosynthetic material from the same production facility where the tooling and raw materials of production have not changed during manufacturing. Owner has the option to increase the frequency of conformance testing or to sample and test any questionable roll or lot.

B. Conformance testing of the geomembrane shall include, but not be limited to, the following properties:

1. Core Thickness, ASTM D 5994
2. Asperity Height, ASTM D 7466
3. Tensile Properties, ASTM D 6693
4. Tear Resistance, ASTM D 1004, Die C
5. Interface Shear Strength, ASTM D 5321
6. Puncture Resistance, ASTM D 4833

C. Engineer may revise the test methods used for determination of conformance properties to allow for use of new or revised methods.

D. All geomembrane conformance test results shall comply with the requirements of Tables 1 and 2 of this Section prior to installation. Any geomembrane that does not conform to these requirements shall be retested or rejected in accordance with the CQA Plan.

E. Geomembrane that is rejected shall be removed from the project site. Sampling and conformance testing of geomembrane supplied as replacement for rejected material shall be performed by the Owner's Representative.

3.04 Deployment and Placement

A. Geomembrane installer shall sign a letter accepting the condition of the Prepared Subgrade.

B. Geomembrane shall be deployed and placed in general accordance with the Geomembrane Installer's approved field installation drawings. Depending on field conditions, it may be necessary to alter the geomembrane panel arrangement from that shown on the approved field installation drawings. <u>These alterations shall be approved by the Owner's Representative prior to geomembrane deployment</u>.

C. Geomembrane Installer shall maintain a daily field record of actual placement of each geomembrane panel, noting subgrade conditions, weather, seaming parameters, panel numbers placed, seams completed, samples taken, and tests run. A copy of each day's field record shall be furnished to the Owner's Representative no later than the following work day.

D. Geomembrane shall only be placed on the Cushion Geotextile that has been installed in accordance with the Drawings and Specifications, and has been accepted in writing by the Contractor, Geomembrane Installer, and Owner's Representative. Once prepared subgrade or Cushion Geotextile has been accepted by the Owner's Representative to receive geomembrane, any additional surface preparation that the Contractor or Geomembrane Installer feels necessary to meet the requirements of the Specifications shall be the responsibility of the Contractor.

E. Cushion Geotextile shall be free of rocks, dirt, tools, or other debris before placing geomembrane. Areas the Geomembrane Installer believes exhibit deficient subgrade conditions shall be reported to the Owner's Representative and Owner for repair.

F. It is imperative to keep surface water runoff from beneath the geomembrane at all times during installation. Geomembrane Installer's panel placement and seaming techniques and schedule shall minimize or eliminate the potential for accumulation of water beneath the geomembrane. Any water found ponded beneath the geomembrane after it has been installed shall be removed by the Contractor, as directed by the Owner's Representative. Any Prepared Subgrade beneath installed geomembrane that has become excessively moist, soft, or unsuitable to perform its intended function, shall be removed and replaced by the Contractor, as directed by the Owner's Representative.

G. Equipment and tools used to deploy and place geomembrane shall not stretch, score, scratch, crease, or otherwise damage the geomembrane, and shall not damage any underlying Compacted Soil Liner.

H. Under no circumstances shall any construction or vehicular traffic be allowed to drive over exposed geomembrane. Geomembrane showing evidence of trafficking shall be inspected by the Geomembrane Installer, Contractor, and Owner's Representative to evaluate damage, if any. At the direction of the Owner's Representative, any damaged geomembrane shall be tested, rejected, or repaired. Owner's Representative may allow limited use of four-wheeled all-terrain vehicles or other low ground pressure equipment (having 5 pounds per square inch or less contact pressure) by the Geomembrane Installer during installation, but use shall be prohibited if excessive trafficking or any geomembrane damage, including scratches, is observed.

I. Geomembrane shall be unrolled and placed in such a manner as to minimize dragging of panels into position ("spotting"). Geomembrane Installer shall immediately provide temporary anchorage of the geomembrane to prevent wind uplift, panel movement during field seaming, and bridging (refer to Part 3.04.K of this Section for bridging requirements). Temporary anchorage methods shall be approved by the Engineer and Owner's Representative. If bags are used for temporary anchorage, they shall be filled with fine-grained sand that has been approved for use by the Owner's Representative. Any geomembrane exhibiting damage due to insufficient or improper temporary anchorage shall be repaired or replaced, as directed by the Owner's Representative.

J. Geomembrane Installer shall place and seam geomembrane panels to provide adequate, well distributed slack to account for thermal expansion or contraction of the geomembrane. For this purpose, the Geomembrane Installer may use a working range of geomembrane sheet temperatures from 35 to 150 degrees Fahrenheit (°F) to determine required techniques. In critical areas such as sumps, pipe trenches, and corners, the Geomembrane Installer may propose slack control techniques for approval by the Engineer.

K. Geomembrane shall be installed so as to minimize or eliminate bridging ("trampolining") at the toe of slopes or within pipe trenches down to temperatures as low as 32°F. Bridging control measures may include providing slack, using and maintaining additional temporary anchorage (e.g., sandbagging), or other methods approved by the Engineer. If bridging is observed, Geomembrane Installer shall repair affected areas, as directed by the Owner's Representative.

L. Scratches on the geomembrane surface caused during geomembrane handling, deployment, or by placement or transport of geomembrane or overlying materials, shall be evaluated for repair by the Owner's Representative. Excessive scratches may result in removal and replacement of the entire affected panel.

M. Panel seams shall be oriented in a direction parallel to the line of maximum subgrade slope (i.e., down, not across the slope) and shall be placed in a manner that minimizes the number and length of field seams. In corners and odd-shaped geometric locations, the number of field seams shall be minimized and moved to locations outside the corners as appropriate.

N. For geomembrane placed on slopes, panels shall be shingled such that the "upstream" panel overlaps the "downstream" panel in order to minimize infiltration potential.

O. No butt seams are permitted across sideslopes parallel to the toe of slope. Liner panels shall extend at least 10 feet beyond the toe of slope before making a longitudinal seam, except where explicitly approved by the Owner's Representative.

P. All panel seams parallel to the toe of a slope ("longitudinal seams") shall be located at least 10 feet from the toe of the slope, except where explicitly approved by the Owner's Representative. No longitudinal seams are permitted on sideslopes.

Q. All geomembrane panels shall be permanently seamed on the same day they are placed except where explicitly approved by the Owner's Representative.

R. Contractor shall be responsible for excavation, maintenance, and backfilling of the geomembrane anchor trench. Backfilling of the anchor trench shall commence only after the geomembrane has had sufficient time to expand or contract into its final position <u>and</u> has been approved by the Owner's Representative.

3.05 Seaming

A. Thermo-fusion seaming methods shall be used to join geomembrane panels in the field. A minimum overlap of 4 inches shall be used. Seams shall be hot wedge or extrusion welded as prescribed by the Geomembrane Manufacturer and approved by the Engineer. For joining geomembrane panels, dual hot wedge is the preferred seaming method. Extrusion seaming shall be used primarily for repairs and detailing.

B. Geomembrane Installer shall provide the following equipment, and any required accessories, to complete geomembrane seaming. Equipment shall be provided and maintained in sufficient numbers to avoid delaying Work.

   1. Seaming equipment: Hot wedge (single and dual track), extrusion, and hot air ("leister") welding machines. All seaming equipment shall be equipped with gauges that clearly display wedge temperature, rate of travel, barrel temperature, and nozzle ("pre-heat") temperature, as applicable.

   2. Destructive testing equipment: Punch press and field tensiometer for field destructive testing of geomembrane seams. Punch press shall be capable of

producing die-cut geomembrane specimens in accordance with ASTM D 6392. Tensiometer shall be built to applicable ASTM specifications, be in good working order, and shall be accompanied by evidence of calibration within the last year.

3. Non-destructive testing equipment: Vacuum box, air pump(s) and gauges, and voltage applicator(s) for non-destructive testing of geomembrane seams and repairs. All testing equipment shall be built to applicable ASTM specifications and be in good working order.
4. Portable electric generators: Capable of providing constant voltage under a combined-line load. Generators must have rubber tires or be placed on a layer of cushioning material that does not damage the geomembrane.
5. Miscellaneous equipment: Any other equipment or tools (e.g., hook blades, scissors, markers, etc.) necessary to complete geomembrane seaming, testing, and labeling in accordance with these Specifications and the Geomembrane Installer's approved CQA manual.

C. No production seaming shall commence until trial seaming, as outlined in Part 3.05 of this Section, is successfully completed and accepted by the Owner's Representative.

D. The Engineer and Owner, in conjunction with the Geomembrane Installer and Contractor, shall establish site-specific limits of weather conditions, including, but not limited to, temperature, humidity, precipitation, and wind speed and direction, within which geomembrane panel placement and seaming can be conducted. In the absence of site-specific criteria, the following limitations shall apply:

1. No placement or seaming shall be conducted in the presence of precipitation, such as rain, snow, sleet, dew, or fog.
2. No placement or seaming shall be conducted in the presence of winds in excess of 20 miles per hour, when dirt or debris is blown into seaming areas, or when seaming temperatures cannot be adequately monitored and controlled.
3. Seaming shall not be conducted when geomembrane sheet temperature falls below 35°F unless approved by the Owner's Representative. In order for seaming to be approved, Geomembrane Installer shall be required, at a minimum, to prepare additional trial seams to demonstrate conformance with these Specifications. Engineer reserves the right to require additional destructive seam testing when seaming is conducted at geomembrane sheet temperatures below 35°F. Geomembrane Installer shall be prepared to pre-heat seaming areas prior to production seaming in accordance with Geomembrane Manufacturer recommendations.
4. Seaming shall not be conducted when geomembrane sheet temperature exceeds 150°F unless approved by the Owner's Representative. Criteria for demonstration of conformance shall be outlined by the Engineer.

E. For purposes of monitoring production seaming, geomembrane sheet temperature shall be measured and recorded by the Owner's Representative at multiple locations along seam overlap areas.

F. Geomembrane Installer shall not cause excessive overheating of the geomembrane during trial or production seaming. Excessive overheating is defined as any of the following:

1. Application of seaming temperatures or seaming rates that result in visible warping, deformation, or discoloration of the bottom surface of the lower geomembrane in the seam area.
2. Seaming over an existing seam ("piggybacking"), except for repairs (patches, cap strips, etc.) which cross over existing seams.
3. Seaming using temperatures in excess of the Geomembrane Manufacturer's recommended seaming temperatures as defined at the pre-installation meeting.

G. All extrusion seaming material shall be of a type or types recommended by the Geomembrane Manufacturer and shall be delivered to the project site in original sealed containers or packaging, each with an indelible label bearing the manufacturer's name, manufacturer's batch or lot number, and complete directions as to proper storage and use.

H. Storage of fuel, oils, and other petroleum products shall be restricted to off-geomembrane areas. Similarly, fueling of equipment (e.g., generators) and changing of oil and oil filters shall be restricted to off-geomembrane areas. If any fuel, oils, or other petroleum products are leaked or accidentally spilled on the geomembrane, they shall be immediately removed. The spill area shall be inspected for damage by the Contractor, Geomembrane Installer, and Owner's Representative, and any damaged geomembrane shall be repaired or replaced as directed by the Owner's Representative.

I. Trial Seaming

1. Geomembrane Installer shall be responsible for field destructive testing of all trial seams.
2. Trial seams shall be prepared for each piece of seaming equipment whenever any of the following conditions occur:
    a. Shift start-up.
    b. Every 4 to 6 hours of continuous seaming within a shift.
    c. "Cold" restart of seaming equipment.
    d. Change in welding technician.
    e. Significant change in geomembrane sheet temperatures.
    f. As required by the Owner's Representative.
3. Trial seams shall be prepared in the presence of the Owner's Representative of CQA Personnel using the same personnel, equipment, and seaming conditions that will be used during production seaming. Field destructive test results acceptable to the Owner's Representative shall be obtained prior to performing any production seaming. This may require resampling of completed trial seams or repeating the trial seam process, as directed by the Owner's Representative.
4. Trial seams shall have a minimum length of 6 feet and minimum width of one-foot, with the seam centered across the width. Geomembrane Installer shall cut the trial seam into two equal length samples suitable for testing. One sample shall be kept by the Geomembrane Installer for destructive testing at the project site in the presence of the Owner's Representative. The duplicate sample shall be furnished to the Owner's Representative for the project record and possible future testing. Geomembrane Installer shall mark the duplicate sample with the date, time,

ambient temperature, seaming machine identification, seaming technician initials, and seaming parameters (set temperature, rate of travel, etc.) used to prepare the trial seam.

5. Trial seam samples shall be destructively tested in peel and shear in accordance with the Geomembrane Installer's approved CQA manual. A minimum of four specimens shall be tested in peel and one in shear for each trial seam. For dual hot wedge seams, four specimens must be tested in peel for each external seam track. Test specimens shall be die cut by the Geomembrane Installer using a die and punch press capable of producing specimens in accordance with ASTM D 6392. Specimens shall be cut from the center two-thirds of the trial seam sample once it has cooled to ambient temperature.

6. Qualification criteria for all trial seam destructive testing are summarized in Table 3 of this Section. Acceptable failure of seam specimens shall be in the geomembrane sheet, not within the seam itself. A partial seam separation ("peel incursion") during testing will be accepted as indicated in Table 3. Excessive peel incursion within the seam area shall constitute disqualification even if strength criteria are met. If any specimens fail to meet qualification criteria, Owner's Representative may have additional specimens from the sample tested in order to determine trial seam acceptance. Failures attributed to excessive grinding beyond weld bead areas for extrusion seams may require retesting or preparation of a new trial seam, as directed by the Owner's Representative.

7. If a trial seam fails to meet all qualification criteria, a new trial seam must be prepared. If this second trial seam also fails, the seaming equipment and/or seaming technician preparing the trial seams shall not be allowed to perform production seaming until any deficiencies are corrected and two consecutive trial seams meeting all qualification criteria are prepared and accepted by the Owner's Representative.

8. Trial seam test results shall be recorded in the Geomembrane Installer's "preweld" test log or daily field record and a copy furnished to the Owner's Representative no later than the following work day. Specimens tested by the Geomembrane Installer shall be marked and stored on the project site for inspection by the Engineer or Owner.

J. Production Seaming

1. No production seaming shall commence until trial seaming, as outlined in Part 3.05.I of this Section, is successfully completed and accepted by the Owner's Representative.

2. All geomembrane panels shall be permanently seamed on the same day they are placed except where explicitly approved by the Owner's Representative.

3. Geomembrane that is to be hot wedge seamed shall be prepared as follows:

   a. Position geomembrane sheets to create a minimum overlap of 4 inches. If the overlap is excessive, excess geomembrane shall be trimmed from the lower sheet where possible. If excess geomembrane is trimmed from the upper sheet, Geomembrane Installer shall not scratch or score the lower sheet. Geomembrane damaged during trimming may be removed and the panel overlap reset, as directed by the Owner's Representative.

b. Temporarily anchor sheets in a manner approved by the Owner's Representative to prevent movement during seaming and to maintain a '"flat" lap of sheets. No glue or tape shall be used to temporarily hold sheets together before seaming.

c. Prepare overlap area to provide a suitable welding surface. Overlap area shall be free of dirt, dust, moisture, or other foreign material. No solvents shall be used to clean geomembrane sheets prior to seaming.

d. Seaming shall be completed as soon as is practical after preparation and cleaning is completed.

4. Geomembrane that is to be extrusion seamed shall be prepared as follows:

   a. Position geomembrane sheets to create a minimum overlap of 4 inches.

   b. Grind the edge of the upper geomembrane sheet to a 45 degree bevel using a disc grinder or equivalent tool. Lift the upper geomembrane sheet away from the lower sheet during beveling to prevent gouging of the lower sheet.

   c. Temporarily bond geomembrane sheets, using hot air ("leister") equipment, to prevent movement during seaming and to maintain a 'flat" lap of sheets. No glue or tape shall be used to temporarily hold sheets together before seaming. Overheating of the geomembrane during temporary bonding shall result in rejection of the seam or repair in question and shall be repaired as directed by the Owner's Representative.

   d. Grind geomembrane surfaces that are to receive the extrusion weld bead, using a disc grinder or equivalent tool, no more than 15 minutes prior to seaming. Grinding area shall extend no more than 0.25-inch beyond the extrusion weld bead area and the grinding depth shall not exceed 10 percent of the geomembrane sheet thickness. Extrusion seam ends that are more than 5 minutes old shall be ground prior to joining or extending the seam. All geomembrane residue generated during grinding shall be cleared from the seaming area.

   e. Prior to extrusion seaming, Owner's Representative shall visually inspect all prepared geomembrane surfaces to verify that excessive grinding has not occurred and that the upper geomembrane sheet is properly beveled. Owner's Representative may require repair of areas exhibiting excessive grinding or improper beveling, which may include removal and replacement of affected geomembrane.

5. Extrusion welding machines are to be purged of all heat-degraded extrudate prior to seaming. During seaming operations, extrudate purging will be required whenever the welding machine is idle for more than two minutes, or as directed by the Owner's Representative.

6. No folds, wrinkles, or "fish-mouths" shall be allowed within any seam areas. Where wrinkles or folds occur, the material shall be cut, overlapped, and a patch applied. During wrinkle or fold repairs, adjacent geomembrane may not be required to meet the 4-inch minimum overlap, if approved by the Owner's Representative.

K. Non-Destructive Testing

1. Geomembrane Installer shall be responsible for non-destructive testing of the entire length (100 percent) of all production seams and repairs to verify their continuity. Non-destructive testing shall be conducted as geomembrane seaming and repair work progresses and shall be performed in the presence of the Owner's Representative or CQA Personnel.

2. Non-destructive test methods shall include the vacuum test, air-pressure test, spark test, or other methods approved by the Engineer. Non-destructive testing procedures shall be described in the Geomembrane Installer's approved CQA manual and shall comply with all requirements of these Specifications and the project CQA Plan.

3. Seams or portions of seams that cannot be non-destructively (vacuum or air pressure) tested due to access constraints or other reasons shall be spark tested. Cap strips may be used only with the approval of the Owner's Representative.

4. Geomembrane Installer shall submit copies of all non-destructive testing documentation to the Engineer in accordance with Part 1.04.C.2.c of this Section.

L. Destructive Testing

1. Laboratory destructive testing of production seams is the responsibility of the Owner's Representative. Field destructive testing of production seams is the responsibility of the Geomembrane Installer. Geomembrane Installer is also responsible for obtaining samples and repairing sampling locations for all laboratory and field destructive testing.

2. Destructive testing sample locations shall be repaired in accordance with Part 3.06 of this Section.

3. Production seam samples suitable for laboratory destructive testing shall be obtained by the Geomembrane Installer at locations established by the Owner's Representative as production seaming progresses. All seaming equipment and welding technicians will be representatively sampled at a rate of one sample per 1,000 linear feet of production seam or a minimum of one per day as deemed necessary by the Owner's Representative. Additional samples shall be obtained by the Geomembrane Installer from areas of questionable integrity, as directed by the Owner's Representative.

4. Laboratory destructive testing samples shall have a minimum length of 3 feet and minimum width of one-foot, with the seam centered across the width. Geomembrane Installer shall cut the destructive sample into two equal length samples suitable for testing. Both samples shall be furnished to the Owner's Representative, who will forward one sample to a Geosynthetics CQA Laboratory where it shall be destructively tested in peel and shear in accordance with ASTM D 6392. The duplicate sample shall be retained by the Owner's Representative for the project record and possible future testing. An additional duplicate destructive sample may be obtained and retained for testing by the Geomembrane Installer at the Installer's discretion.

5. Qualification criteria for all production seam destructive testing are summarized in Table 3 of this Section. Acceptable failure of seam specimens shall be in the geomembrane sheet, not within the seam itself. A partial seam separation ("peel

incursion") during testing will be accepted as indicated in Table 3. Excessive peel incursion within the seam area shall constitute disqualification even if strength criteria are met. If any specimens fail to meet qualification criteria, Owner's Representative may have additional specimens from the sample tested in order to determine production seam acceptance. Failures attributed to excessive grinding beyond weld bead areas for extrusion seams may require resampling and retesting, as directed by the Owner's Representative. Owner's Representative shall determine acceptance of any destructive testing in cases of dispute.

6. If a destructive test sample fails to meet all qualification criteria, Geomembrane Installer shall obtain additional production seam samples for laboratory destructive testing as required by the project CQA Plan. Testing of these samples shall be performed by the Owner's Representative at the Geomembrane Installer's expense. Resampling and associated repairs shall be the responsibility of the Geomembrane Installer at no cost to the Owner.

7. In order for a production seam to be accepted, a failed destructive test sample shall be bounded by two passing destructive test samples, and the seam between the two passing test locations shall be reconstructed. Alternatively, the entire length of the seam in question may be repaired by placement of a cap strip, or by another repair procedure, as directed by the Owner's Representative.

8. The Owner's Representative, Engineer, or Owner may require that additional destructive test samples be taken at random locations from production seams completed during the same work shift as a failing destructive test sample or in areas that visually appear defective or not in accordance with these Specifications. Testing of these samples shall be performed by the Owner's Representative, but obtaining the samples and repairing the sampling locations shall be the responsibility of the Geomembrane Installer.

3.06 Repairs

A. During installation, Geomembrane Installer and Owner's Representative and CQA Personnel shall visually inspect all geomembrane panels and seams for damage, defects, or non-compliance with the Drawings and Specifications, and shall mark any such areas for repair. Geomembrane Installer shall repair marked areas as soon as possible. Any defects that could allow surface water runoff beneath the geomembrane shall be repaired on the same day they are marked.

B. Acceptable geomembrane repair methods include:

1. Patching: For repair of surface defects, small tears, punctures, destructive sampling locations, etc. Patches shall have a minimum size of 12 inches by 12 inches, extend at least 6 inches beyond the edge(s) of a defect, and have rounded corners so that the repair may be completed with a continuous extrusion seam. In some cases, the Owner's Representative may direct the Geomembrane Installer to cut out and remove a defect prior to patching in order to minimize the risk of crack propagation.

2. Spot welding ("bead repairs"): For repair of pinholes or other minor, localized defects. Spot welding shall only be permitted where explicitly approved by the Owner's Representative prior to performing the repair.

3. Reconstruction: For repair of lengths (segments) of unacceptable seams. Performed by cutting and removing the unacceptable seam segment and replacing it with new geomembrane that is seamed into place.
4. Cap stripping: For repair of lengths (segments) of unacceptable seams in lieu of reconstruction. Cap strips shall extend at least 12 inches beyond the edge(s) of a seam, and have rounded corners so that the repair may be completed with a continuous extrusion seam.
5. Flap seaming: For repair of small lengths of unacceptable hot wedge seams in lieu of cap stripping. Performed by extrusion seaming the excess upper geomembrane flap of a hot wedge seam to the lower geomembrane sheet. Flap seaming shall only be permitted when the affected area is less than 10 feet in length and is explicitly approved by the Owner's Representative prior to performing the repair.
6. Grinding and reseaming: For repair of small lengths of unacceptable extrusion seams in lieu of cap stripping. Grinding and reseaming shall only be permitted when the affected area is less than 3 feet in length and is explicitly approved by the Owner's Representative prior to performing the repair.

C. Under no circumstances shall seams be repaired by placing extrusion seams directly atop previously seamed areas ("piggybacking').

D. Seam intersections ("tees") shall be covered with a patch meeting the requirements of Part 3.06.B.1 of this Section, except where explicitly approved by the Owner's Representative prior to performing the repair.

E. Owner's Representative may require repair or replacement of any area where excessive grinding, overheating, or unacceptable preparation, seaming or testing techniques are observed. Such repair or replacement may be required even if samples removed from affected areas pass destructive testing.

F. All repairs shall be non-destructively tested by the Geomembrane Installer in accordance with Part 3.05.K of this Section.

3.07 Pipe Penetration Seals

A. Pipe penetrations in the geomembrane shall be sealed using LLDPE pipe boots (sleeves and skirts), neoprene gaskets, and stainless steel banding straps, as shown on the Drawings and specified in Part 2.03 of this Section.

B. Surfaces where pipe boots are to be attached (including HDPE pipe) shall be cleaned to remove dirt, oil, debris, or other deleterious materials. Geomembrane and HDPE pipe surfaces that will be extrusion seamed to a pipe boot are to be prepared in accordance with Part 3.05.J.4 of this Section.

C. Prior to attaching and/or seaming pipe boots, Owner's Representative shall visually inspect all prepared surfaces to verify that proper preparation techniques have been followed. The Owner's Representative may require repair of areas exhibiting improper preparation techniques or damage, which may include removal and replacement of affected geomembrane or pipe.

D. Geomembrane Installer shall be responsible for non-destructive testing of the entire length (100 percent) of all pipe boot extrusion seams to verify their continuity. Non-destructive testing shall be performed in the presence of the Owner's Representative and in accordance with Part 3.05.K of this Section.

3.08 Final Inspection, Acceptance, and Covering

A. A final visual examination of all geomembrane panels, seams, repairs, and pipe penetration seals shall be completed by the Owner's Representative prior to accepting geomembrane. Owner's Representative's inspection shall only be performed following a complete inspection and approval by the Geomembrane Installer's field superintendent or designated quality control technician. Contractor shall be responsible for cleaning, sweeping, or other measures necessary to provide a thoroughly visible geomembrane surface for the Owner's Representative's inspection.

B. Geomembrane Installer shall repair and test any areas identified during the Owner's Representative's final inspection as not being in accordance with the Drawings and Specifications.

C. No geomembrane shall be covered until it has been accepted by the Owner's Representative in writing. Once accepted, geomembrane shall be covered within 5 calendar days of acceptance in accordance with the Drawings and Specifications.

D. If textured geomembrane is to be covered with other geosynthetics (e.g., geotextile), a smooth temporary geosynthetic covering ("slip sheet") shall be used to protect both the geomembrane and overlying geosynthetic from damage until the overlying geosynthetic is in its final position for seaming.

3.09 Warranties

A. Contractor shall be responsible for obtaining any necessary guarantees or certifications from the Geomembrane Manufacturer and Geomembrane Installer and submitting them to the Engineer and Owner prior to acceptance of installed geomembrane.

B. Contractor shall guarantee the integrity, within the realm of limitations of Contractor's responsibility, of the installed geomembrane for its intended use, from installation defects for a period of 2 years from the date of geomembrane installation, and from manufacturing defects for a period of 20 years from the date of geomembrane installation. Such written warranties shall provide for the total and complete repair and/or replacement of any defect or defective areas of geomembrane upon written notification and demonstration by the Owner of the specific non-conformance of the geomembrane or installation with the Drawings and Specifications. Such defects or non-conformance shall be repaired and/or replaced expeditiously.

Table 1
Required Properties of Textured 40 Mil LLDPE Geomembrane(1)

Property (Units)	MQC Testing Frequency (Minimum)	Test Method(2)	Required Value
Resin			
Density (g/cc)	1 per Resin Batch	ASTM D 1505 or D 792	0.939
Melt Flow Index (g/10 min)	1 per Resin Batch	ASTM D 1238, Condition 190/2.16	1.0 (max)
Finished Sheet			
Core Thickness (mil)	Each roll	ASTM D 5994	38 (min ave)(3)
Asperity Height (mil)	Every second roll	ASTM D 7466	16 (min ave)(4)
Density, (g/cc)	Every 200,000 lbs	ASTM D 1505 or D 792	0.939 (max ave)
Carbon Black Content (%)	Every 45,000 lbs	ASTM D 1603(5)	2.0-3.0
Carbon Black Dispersion	Every 45,000 lbs	ASTM D 4218	Categories 1 or 2(6)
Tensile Properties (each direction) Break Strength (lb/in) Break Elongation (%)	Every 20,000 lbs	ASTM D 6693 Type IV Test in machine direction and cross-machine direction	 103(min ave) 400 (min ave)
Tear Resistance (lb)	Every 45,000 lbs	ASTM D 1004	22 (min ave)
Puncture Resistance (lb)	Every 45,000 lbs	ASTM D 4833	48 (min ave)
Oxidative Induction Time (mins)(7) Standard OIT	Every 200,000 lbs	ASTM D 3895	100 (min ave)
Oven Aging at 85 degrees Celsius (°C) High Pressure OIT (percent retained after 90 days)	Per each formulation	ASTM D 5885	60 (min ave)
UV Resistance(8) High Pressure OIT (percent retained after 1,600 hours)	Per each formulation	ASTM D 5885	35 (min ave)

Notes:

(1) The required properties specified herein may be revised by the Engineer to reflect new or revised test methods or to conform with improvements to the state-of-the practice.

(2) Number of specimens per test established in applicable test method unless otherwise noted.

(3) Lowest individual value for eight out of 10 readings = 36 mil; lowest individual value for one out of 10 readings = 34 mil.

(4) Alternate side of sheet measured each time a roll is tested.

(5) ASTM Method D 4218 is acceptable if an appropriate correlation to D 1603 can be established.

(6) For 10 different views: nine in Categories 1 or 2 and one in Category 3. Only near spherical agglomerates are to be considered.

(7) Geomembrane Manufacturer may select either of the OIT methods listed to evaluate antioxidant content.

(8) Condition of test should be 20-hour UV cycle at 75°C followed by 4-hour condensation at 60°C.

Table 2
Interface Shear Strength Requirements for Textured 40 Mil LLDPE Geomembrane[1, 2, 3]

Testing Set-Up		
ASTM D5321	Conditioning:	Set up each test to match field placement orientation. Run all tests under wet conditions.
	• Procedure A:	Geomembrane against Cushion Geotextile Substrate: Project Cushion Geotextile Superstratum: Project Textured 40 Mil LLDPE Geomembrane Displacement Rate: 0.04-inch per minute (ipm) (maximum) Total Displacement: 2.50 in (minimum)
	• Procedure B:	Geomembrane against GDN Substrate: Project Textured 40 Mil LLDPE Geomembrane Superstratum: Project GDN Displacement Rate: 0.04 ipm (maximum) Total Displacement: 2.50 in (minimum)
	• Procedure C:	Geomembrane against Prepared Subgrade Substrate: Project Textured 40 Mil LLDPE Geomembrane Superstratum: Project Prepared Subgrade Displacement Rate: 0.04 ipm (maximum) Total Displacement: 2.50 in (minimum)
	• Special Instructions:	None.

Strength Requirements	
Normal Stress [Pounds per Square Foot (psf)]	**Minimum Peak Shear Strength**
150	20 Degrees
300	
600	
1000	

Notes:

(1) Test individual interfaces between Steel rasp platens. In lieu of testing individual interfaces, a system test may be performed using a configuration that allows failure to occur through the weakest shearing plane. System test configuration, conditions, and procedures must be accepted by the Engineer prior to submitting test results for review and approval. Testing frequency as per CQA Plan.

(2) Interfaces shall be saturated for a minimum of 24 hours prior to testing.

(3) Geosynthetics shall be oriented such that the shear force is parallel to the down slope orientation of these components in the field.

Table 3
Seam Qualification Criteria for Textured 40 Mil LLDPE Geomembrane(1)

	Trial Seaming(1, 3)	Production Seaming(2, 3, 4)
Hot Wedge Seams		
Peel Strength (lbs)	50	50
Peel Incursion (%)	25	25
Shear Strength (lbs)	60	60
Shear Elongation at Break (%)	----	50
Extrusion Fillet Seams		
Peel Strength (lbs)	44	44
Peel Incursion (%)	25	25
Shear Strength (lbs/in)	60	60
Shear Elongation at Break (%)	----	50

Notes:

(1) Field test in accordance with project Specifications and CQA Plan.

(2) Laboratory test in accordance with ASTM D 6392. For production seaming, values listed for shear and peel strengths are for four out of five test specimens; the fifth specimen can be as low as 80 percent of the listed value.

(3) Seam tests for peel and shear must fail in the Film Tear Bond mode. This is a failure in the ductile mode of one of the bonded sheets by tearing or breaking prior to complete separation of the bonded area.

(4) Where applicable, both tracks of a double hot wedge seam shall be tested for peel strength.

-End of Section-

SECTION 02598
Geosynthetic Clay Liner

Section 02598
Geosynthetic Clay Liner

Part 1 General

1.01 Summary

A. All supervision, labor, products, equipment, and tools, shall be furnished including all necessary and incidental items as detailed or required, to install GCL in accordance with the Contract Drawings, Specifications, and project CQA Plan.

B. GCL perimeter liner termination area shall be excavated, maintained, ballasted, and backfilled.

1.02 References

A. ASTM Standards:

1. D 4632, "Standard Test Method for Grab Breaking Load and Elongation of Geotextiles".
2. D 4643, "Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method".
3. D 5261, "Standard Test Method for Measuring Mass per Unit Area of Geotextiles".
4. D 5887, "Standard Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Using a Flexible Wall Permeameter".
5. D 5888, "Standard Guide for Storage and Handling of Geosynthetic Clay Liners".
6. D 5889, "Standard Practice for Quality Control of Geosynthetic Clay Liners".
7. D 5890, "Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners".
8. D 5891, "Standard Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners".
9. D 5993, "Standard Test Method for Measuring Mass per Unit of Geosynthetic Clay Liners".
10. D 6072, "Standard Guide for Obtaining Samples of Geosynthetic Clay Liners".
11. D 6102, "Standard Guide for Installation of Geosynthetic Clay Liners".
12. D 6243, "Standard Test Method for Determining the Internal and Interface Shear Resistance of Geosynthetic Clay Liner by the Direct Shear Method".
13. D 6495, "Standard Guide for Acceptance Testing Requirements for Geosynthetic Clay Liner".
14. D 6496, "Standard Test Method for Determining Average Bonding Peel Strength between the Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners".

1.03 Definitions

A. MARV: Minimum Average Roll Value. For geosynthetics, the value calculated as the typical value minus two standard deviations from documented quality control test results for a defined population from one specific test method associated with one specific property.

1.04 Submittals

A. Submittals shall be submitted in a timely fashion for review.

B. The following submittals shall be provided with Contractor's Bid:

1. The GCL and GCL Manufacturer must be approved prior to material shipment. Submittals for approval include:

a. GCL Manufacturer's specification sheet(s) demonstrating compliance with the requirements of Table 1 of this Section.

b. GCL Manufacturer's historical data for 10,000 hour large-scale constant load ("creep") shear testing. Creep testing shall have been performed on hydrated reinforced GCL at a normal stress of 500 psf and at a constant shear stress of 250 psf.

C. Written certification that the GCL Manufacturer has produced a minimum of 10,000,000 square feet of GCL that has been installed for hydraulic containment purposes in the last 4 years, including a list of the relevant completed facilities. Each entry in this list should include the name, location, and purpose of the facility; GCL product designation, total square footage, and date of installation; Designer, and GCL Installer; and the name and telephone number of a contact at the facility who can discuss the project.

D. A copy of the GCL Manufacturer's MQC manual. This manual should describe the quality control program(s) for GCL components (bentonite clay, geotextiles, etc.) and finished GCL, and indicate the properties, test methods, and testing frequencies used for each. GCL Manufacturer shall modify the MQC manual to comply with the requirements of these Specifications, with any variations, deviations, or exceptions clearly noted in an attached letter.

1. The GCL Installer must be approved prior to material shipment. Submittals for approval include:

a. Written certification that the GCL Installer has installed a minimum of 2,000,000 square feet of GCL for hydraulic containment purposes in the last 2 years, including a list of the relevant completed facilities. Each entry in this list should include the name, location, and purpose of the facility; GCL product designation, total square footage, and date of installation; Designer, and the name and telephone number of a contact at the facility who can discuss the project.

b. A copy of the GCL Installer's CQA manual. This manual should describe the quality control program(s) for handling, deploying, anchoring, seaming, and repairing GCL. GCL Installer shall modify the CQA manual to comply with the requirements of these Specifications and the project CQA Plan, with any variations, deviations, or exceptions clearly noted in an attached letter.

E. The following submittals shall be provided after award of material shipment:

1. GCL Manufacturer:

a. Prior to or coincident with shipment of GCL to the project site, submit written certification and supporting test data, in the form of Quality Control Certificates, documenting that all GCL components (sodium bentonite and non-woven geotextile) and finished GCL shipped to the project site comply with the requirements of Part 2.01 of this Section. GCL Quality Control Certificates must be reviewed and signed by a responsible representative of the GCL Manufacturer and shall include copies of all quality control certificates issued by the sodium bentonite and non-woven geotextile manufacturers.

b. Prior to or coincident with shipment of GCL to the project site, submit written certification stating that the GCL and accessory bentonite shipped to the project site were produced using the same sodium bentonite. Include supporting test data documenting that accessory bentonite complies with the requirements of Parts 2.01 and 2.02 of this Section.

2. GCL Installer:

a. Four weeks prior to shipment of GCL to the project site, submit field installation drawings for approval. Installation drawings shall show the proposed length, width, and position of all GCL panels and the location of all side seams. Installation drawings shall also show complete details for any proposed alternative installation methods. If any proposed alternative installation details are not accepted the details provided on the construction drawings will be used.

b. Within 1 week after completion of GCL installation, submit a written report containing the following:

1) Written certification stating that the GCL has been installed in accordance with the Contract Drawings, Specifications, and project CQA Plan;

2) Product and installation warranties as required by Part 3.08 of this Section; and

3) Copies of daily field records.

1.05 CQA and Quality Assurance

A. GCL CQA will be performed by the GCL Installer in accordance with the CQA manual approved.

B. GCL CQA will be performed in accordance with these Specifications and the project CQA Plan.

Part 2 Products

2.01 GCL

A. The GCL and GCL Manufacturer must be approved prior to Contract award, as required by Part 1.04 of this Section.

B. GCL shall consist of a layer of sodium bentonite clay encapsulated between two non-woven needle-punched PP geotextiles, and shall be fully needle-punched throughout to provide internal shear reinforcement. The physical, mechanical, and chemical properties of the reinforced GCL shall comply with the requirements of Table 02598-1 of this Section.

C. Sodium bentonite used in the manufacture of GCL is to be processed specifically for producing GCL. Incoming sodium bentonite shall be sampled and tested in accordance with the GCL Manufacturer's approved MQC manual. Testing frequencies, test procedures, and sodium bentonite properties shall comply with the requirements of Contractor of this Section. Results from the sodium bentonite sampling and testing program are to be submitted in accordance with Part 1.04 of this Section.

D. Geotextile used in the manufacture of GCL shall be non-woven needle-punched PP meeting the physical, mechanical, and chemical property requirements of Table 02598-1 of this Section. PP resin used in the manufacture of geotextile is to be made from virgin, uncontaminated ingredients and shall be designed and manufactured specifically for producing geotextile. Geotextile formulations shall contain no plasticizers, fillers, extenders, or PCR. During production, geotextile shall be continuously inspected for the presence of broken needles, which shall be removed from the finished product. Geotextile shall be sampled and tested, prior to incorporation into finished GCL, in accordance with the GCL Manufacturer's approved MQC manual. Testing frequencies, test procedures, and geotextile properties shall comply with the requirements of Table 02598-1 of this Section. Results from the geotextile sampling and testing program are to be submitted in accordance with Part 1.04 of this Section.

E. During production, finished GCL shall be sampled and tested in accordance with the GCL Manufacturer's approved MQC manual. Testing frequencies, test procedures, and finished GCL properties shall comply with the requirements of Table 02598-1 of this Section. Results from the finished GCL sampling and testing program, in the form of Quality Control Certificates, are to be submitted in accordance with Part 1.04 of this Section.

F. GCL shall be produced free of holes, tears, contamination by foreign matter, dimensional abnormalities, or other defects. During production, GCL shall be continuously inspected for the presence of broken needles, which shall be removed from the finished product. All or portions of units (rolls) of GCL shipped to the project site may be rejected if significant production flaws are observed.

G. GCL shall be manufactured as a continuous panel having a nominal width of 14.5 feet and minimum length of 150 feet in order to reduce the amount of field seaming required during installation. Rolls of GCL having lengths shorter than 150 feet may be shipped to the project site if the number of such rolls is approved prior to shipment.

H. GCL shall be rolled onto hollow cores having a minimum inside diameter of 4 inches to allow the use of a stinger or spreader bar assembly for handling and deployment. Cores shall be of stable construction such that they support the roll without excessively deflecting, buckling, or otherwise failing during handling, transportation, and storage. Each roll of GCL shall be protected by wrapping it in packaging that is waterproof, resistant to photo degradation by UV light, and completely covers all exposed GCL surfaces and edges.

I. Each GCL roll shall be labeled to identify the GCL Manufacturer, product designation, manufacturer's batch or lot number, manufacturer's roll number, and the length, width, and weight of each roll. Roll identification numbers shall conform to the numbering system established on the GCL MQC Certificates. Labels shall be weather proof, legible, and located so that each roll of GCL can be identified by examining the outside of the roll or the core ends.

J. The GCL manufacturing process may be inspected on a full-time basis. This inspection program would include conformance sampling as required. If requested, GCL Manufacturer shall submit a production schedule during plant inspection.

K. All GCL components and finished GCL properties, including testing frequencies and test procedures used, shall meet the requirements of this Section. Manufacturing records, including test data, shall be maintained by the GCL Manufacturer for 2 years after acceptance of the GCL, and shall be made available upon request.

2.02 Accessory Bentonite

A. Granular bentonite sealing clay or bentonite mastic to be used for overlap seaming, penetration sealing, and repairs shall be made from the same sodium bentonite as used in the GCL.

B. Accessory bentonite shall be sampled and tested in accordance with the GCL Manufacturer's approved MQC manual. Accessory bentonite shall meet the sodium bentonite requirements of Table 02598-1 of this Section. Testing frequencies and test procedures shall comply with the requirements of Table 02598-1, as applicable. Results from the accessory bentonite sampling and testing program are to be submitted in accordance with Part 1.04 of this Section.

Part 3 Execution

3.01 Pre-Installation Meeting

A. Prior to scheduled GCL installation, a pre-installation meeting at the project site shall occur. This meeting shall be scheduled after receipt of GCL Installer's field installation drawings.

B. GCL Installer shall be represented by both the project field superintendent and the project manager.

C. At the pre-installation meeting, site safety and rules of operation, scheduling, methods of installation, and CQA and quality assurance shall be discussed. All parties shall at this time agree to the required GCL placement, seaming, and repair procedures for the project.

3.02 Shipping, Handling, and Storage

A. GCL damaged during shipping, unloading, or storage shall be repaired or replaced.

B. GCL rolls shall be packaged and shipped so that no damage, including hydration, is caused during delivery to the project site. GCL shipping shall be by open or enclosed trailers loaded in such a manner that rolls can be readily unloaded at the project site using a stinger or spreader bar assembly. GCL rolls shipped by open trailer shall be protected with a sacrificial or temporary cover during shipment.

C. During unloading at the project site, a surface inspection of all GCL rolls shall be conducted for defects and damage, including damage to the original protective packaging. Any defects or damage observed shall be notified immediately.

D. Extreme care shall be taken by all personnel while unloading and handling GCL. Equipment used to unload and handle GCL shall have sufficient capacity to manage the roll weight without damaging the GCL. GCL shall only be unloaded and handled using a stinger or spreader bar assembly meeting the requirements of ASTM D 5888 or as recommended by the GCL Manufacturer. Pushing, sliding, or dragging of GCL rolls is not permitted. CQA Personnel shall have the option of inspecting all GCL panels, prior to final placement, to verify that all defects or damage are identified for repair.

E. The storage area shall be graded so that it is reasonably level and well drained, and shall prepare the ground surface so that it is firm, smooth, and free of stones, sticks, or other materials that may damage the GCL.

F. GCL rolls shall be stored off the ground and continuously supported along their length. Stacking of GCL rolls for storage is allowed but should not be so high that crushing of cores, flattening of rolls, or thinning of the GCL occurs. In general, the maximum stacking limit is three rolls high. A suitable means of securing the rolls shall be used so that shifting or other adverse movement does not occur.

G. During storage, GCL rolls and accessory bentonite shall be protected from moisture, direct sunlight, mud, and excessive dust by covering them with a plastic sheet or waterproof tarpaulin. Roll labels shall remain intact and legible. Any roll of GCL that has no label or where the label is damaged or otherwise illegible may be rejected by the CQA Consultant. GCL rolls shall be kept in their original protective packaging until immediately before they are to be deployed.

3.03 Quality Assurance Conformance Testing

A. Quality assurance conformance testing of the GCL shall be performed. Conformance sampling and testing shall be completed in accordance with the project CQA Plan, with at least one sample per production lot as directed. The frequency of conformance testing may be increased to sample and test any questionable roll or lot.

B. Conformance testing of the GCL shall include, but not be limited to, the properties listed on Table 02598-1.

C. The test methods used for determination of conformance properties may be revised to allow for use of new or revised methods.

D. All GCL conformance test results shall comply with the requirements of Table 02598-1 of this Section prior to installation. Any GCL that does not conform to these requirements shall be retested or rejected in accordance with the CQA Plan.

E. GCL that is rejected shall be removed from the project site and replaced. Sampling and conformance testing of GCL supplied as replacement for rejected material shall be performed.

3.04 Deployment and Placement

A. The GCL liner installation shall not begin until the low permeability clay liner surface and CCR surface have been prepared to accept the GCL liner. The low permeability clay liner and CCR surfaces shall be maintained in a firm and dry condition during the installation of GCL liner.

B. The Contractor and Installer shall provide to the Owner's Representative a certificate of acceptance of the soil liner layer surface for each area of installation as stated in 1.04.

C. It shall be the Contractor's responsibility after written acceptance to indicate to the ENGINEER any change in the condition of the low permeability clay liner surface that could cause the low permeability clay liner surface to be out of compliance with any of the requirements listed in these specifications. The Contractor shall perform repair(s) at no additional costs to the OWNER.

D. GCL shall be deployed and placed in general accordance with the GCL Installer's approved field installation drawings. Depending on field conditions, it may be necessary to alter the GCL panel arrangement from that shown on the approved field installation drawings. These alterations shall be approved prior to GCL deployment.

E. Site-specific limits of weather conditions shall be established, including, but not limited to, temperature, precipitation, and wind speed and direction, within which GCL panel placement can be conducted. Acceptable weather conditions will be governed by the geomembrane used to cover the GCL.

F. GCL Installer shall maintain a daily field record of actual placement of each GCL panel, noting GCL subbase conditions, weather, panel numbers placed, and seaming methods. A copy of each day's field record shall be furnished to the CQA Consultant no later than the following workday.

G. Surfaces (low permeability clay liner surface and CCRs) that are to receive GCL shall be prepared in accordance with the Contract Drawings and Specifications. GCL Installer shall install GCL only on surfaces that have been approved in writing.

H. GCL Installer shall coordinate placement of GCL with placement of the covering material (geomembrane and Protective Cover Soil). All GCL panels shall be covered with geomembrane and Protective Cover Soil as soon as possible after they are placed. Only as much GCL shall be deployed as can be covered by Protective Cover Soil (meeting the requirements of Earthwork Section of the Specifications) in the same workday. No GCL shall be allowed to remain exposed at the end of a workday. Any GCL that becomes hydrated prior to placement of covering Protective Cover Soil shall be removed and replaced, unless otherwise approved by the Owner's Engineer. It is imperative to keep surface water runoff from contacting the GCL at all times during installation. GCL Installer's panel placement techniques and schedule shall minimize or eliminate the potential for accumulation of water beneath or atop the GCL. Any water found ponded on or beneath the GCL after it has been installed shall be removed. Any surface beneath installed GCL that has become excessively moist, soft, or unsuitable to perform its intended function, shall be removed. Any GCL that becomes hydrated due to surface water runoff shall be removed and replaced.

I. Extreme care shall be taken by all personnel while handling, unwrapping, deploying, and placing GCL. Equipment and tools used shall not stretch, tear, or otherwise damage the GCL, and shall not cause rutting or other damage to the underlying surface. Equipment shall have sufficient capacity to manage the roll weight without damaging the GCL. GCL shall only be handled and deployed using a stinger or spreader bar assembly meeting the requirements of ASTM D 5888 or as recommended by the GCL Manufacturer. Pushing, sliding, or dragging of GCL rolls is not permitted.

J. Under no circumstances shall any construction or vehicular traffic be allowed to drive over exposed GCL. GCL showing evidence of trafficking shall be inspected to evaluate damage, if any. Any damaged GCL shall be repaired or replaced. A limited use of four-wheeled ATVs or other low ground pressure equipment may be allowed (having 6 psi or less contact pressure) by the GCL Installer during installation, but use shall be prohibited if excessive trafficking or any GCL damage is observed.

K. GCL rolls shall be transported from the storage area to the working area in their original protective packaging. After packaging is carefully removed, GCL shall be unrolled and placed in such a manner as to minimize dragging of panels into position ("spotting").

L. GCL Installer shall immediately provide permanent anchorage of the GCL to prevent panel movement during placement of covering materials (geomembrane and Common Fill). If bags are used for ballasting or temporary anchorage, they shall be filled with fine-grained sand or approved equal that has been approved for use. Any GCL exhibiting damage due to insufficient or improper temporary anchorage shall be repaired or replaced.

M. GCL shall be installed so that it is in continuous contact with the underlying CCRs, without being tensioned, and with no wrinkles or folds. Bridging at the toe of slopes shall not be permitted. If bridging is observed, GCL Installer shall repair affected areas.

N. GCL panel seams (edges) shall be oriented in a direction parallel to the line of maximum subgrade slope (i.e., down, not across the slope) and shall be placed in a manner that minimizes the number and length of field seams. In corners and odd-shaped geometric locations, the number of field seams shall be minimized and moved to locations outside the corners as appropriate.

O. All GCL panel seams shall be shingled such that the "upstream" panel overlaps the "downstream" panel in order to minimize infiltration potential.

3.05 Seaming

A. Lap joints shall be used to join GCL panels in the field. A minimum overlap of 18 inches shall be used for panel edges. Overlap areas shall be kept free of rocks, loose soil, or other debris. All GCL panels should be seamed as soon as possible after they are placed and prior to being covered with geomembrane.

B. For the primary liner GCL, a continuous bead of accessory bentonite having a minimum width of 6 inches and applied at a minimum rate of one-quarter-pound per linear foot (1/4 lb/LF) of seam shall be placed in all seam overlap areas. This accessory bentonite shall if the GCL product has "supergroove" or other self-seaming enhancements.

C. Seam overlap areas shall be left exposed after placing the accessory bentonite bead to verify that the overlap area and the accessory bentonite bead meet the requirements of this Section. Seam overlaps shall not be "closed" until verbal acceptance of the seam has been received.

D. Completed GCL seams shall lay flat and be free of any rocks, loose soil, or other debris. Where wrinkles or folds do occur, the material shall be cut, overlapped, and a patch applied in accordance with Part 3.06 of this Section.

3.06 Repairs

A. During installation, all GCL panels and seams for damage, defects, or non-compliance shall be inspected with the Contract Drawings and Specifications, and shall mark any such areas for repair. GCL Installer shall repair marked areas as soon as possible and prior to covering the GCL with geomembrane.

B. Acceptable GCL repair methods include:

1. Patching: For repair of surface defects, small tears, punctures, etc. Patches shall have a minimum size of 24 inches by 24 inches and extend at least 12 inches beyond the edge(s) of a defect. Accessory bentonite or bentonite mastic shall be placed around a defect prior to placement of a patch. Where practical, patches shall be placed beneath installed GCL panels. If placed on top of installed GCL panels, patches may be affixed in place using an adhesive. Care shall be taken to prevent fugitive bentonite from accumulating on the upper surface of the GCL and affecting geomembrane seaming operations.

C. In cases where an object beneath the GCL is causing the GCL to protrude more than one-half-inch, the CQA Personnel may direct the GCL Installer to cut the GCL and remove the object prior to patching.

3.07 Acceptance and Covering

A. No GCL shall be covered until it has been accepted.

B. GCL Installer shall repair any areas identified as not being in accordance with the Contract Drawings and Specifications. Once all repairs are completed and accepted, GCL shall immediately be covered with geomembrane in accordance with the Contract Drawings and Specifications.

C. If textured geomembrane is used to cover the GCL, a smooth temporary geosynthetic covering ("slip sheet") shall be used to protect the GCL from damage until the geomembrane is in its final position for seaming.

3.08 Warranties

A. Any necessary guarantees or certifications from the GCL Manufacturer and GCL Installer shall be obtained and submitted them to the ENGINEER and OWNER prior to acceptance of installed GCL.

B. Installer shall guarantee the integrity of the installed GCL for its intended use, from installation defects for a period of 2 years from the date of GCL installation. The Manufacturer of the GCL shall guarantee and from manufacturing defects for a period of 20 years from the date of GCL installation. Such written warranties shall provide for the total and complete repair and/or replacement of any defect or defective areas of GCL upon written notification and demonstration of the specific non-conformance of the GCL or installation with the Contract Drawings and Specifications. Such defects or non-conformance shall be repaired and/or replaced expeditiously.

Table 1
Required Properties of Geocomposite Clay Liner(1)

Material Property	Test Method	Test Frequency $[ft^2(m^2)]^{(2)}$	Required Values
Bentonite Swell Index(3)	ASTM D 5890	Once per 500,000 sf^2	24 ml/2g min.
Bentonite Fluid Loss(3)	ASTM D 5891	Once per 500,000 sf^2	18 ml max.
Bentonite Mass/Area(3)	ASTM D 5993	Once per 500,000 sf^2	0.75 lb./ft^2 (3.6 kg/m^2) min
GCL Tensile Strength(4)	ASTM D 6768	Once per 500,000 sf^2	50 lbs/in (53 N/cm) MARV
GCL Peel Strength(4)	ASTM D 6496	Once per 500,000 sf^2	3.5 lbs/in (6.1 N/cm) min
GCL Hydraulic Conductivity (5)	ASTM D 5887	Once per 500,000 sf^2	5 x 10-9 cm/sec max.
GCL Hydrated Internal Shear Strength6	ASTM D 5321 ASTM D 6243	Once per 500,000 sf^2	500 psf (24 kPa) typ @ 200 psf

Notes:

(1) The required properties specified herein are satisfied by the Bentomat DN as manufactured by CETCO Lining Technologies but may be revised by the ENGINEER to reflect new or revised test methods or to conform with improvements in state-of-the practice.

(2) Number of specimens per test established in applicable test method unless otherwise noted.

(3) Perform tests on as-received material before incorporation into finished GCL.

(4) All tensile strength testing is performed in the machine direction using ASTM D6768. All peel strength testing is performed using ASTM D6496.

(5) Permeability testing with deaired distilled/deionized water at 80 psi (551 kPa) cell pressure, 77 psi (531kPa) headwater pressure, and 75 psi (517kPa) tailwater pressure.

(6) Peak value measures at 200 psf normal stress for a specimen hydrated for 48 hours.

-End of Section-

SECTION 02620

High Density Polyethylene (HDPE) Pipe and Fittings

Section 02620
High Density Polyethylene (HDPE) Pipe and Fittings

Part 1 General

1.01 Section Description

This specification includes but is not limited to high-density polyethylene (PE 3408) pressure pipe primarily intended for the transportation of water and sewage either buried or above grade.

1.02 Related Sections

A. Drain Gravel/Coarse Aggregate - 02233

B. Geotextiles - 02595

C. Geocomposite Drainage Net - 02590

1.03 References

Reference:	**Title:**
AWWA C901	Polyethylene (PE) pressure Pipe & Tubing, ½ inch through 3 inch for water
AWWA C906	Polyethylene (PE) pressure Pipe & Fittings, 4 inch through 63 inch for water
ASTM D3035	Standard Spec for PE Pipe (DR-PR) Based on Controlled Outside Diameter
ASTM D3261	Butt Heat Fusion PE Fittings for PE Pipe & Tubing
ASTM D3350	Standard Specification for PE Pipe & Fittings Materials
ASTM D1238	Melt Flow Index
ASTM D1505	Density of Plastics
ASTM D2837	Hydrostatic Design Basis
ASTM F714	Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
SF Std.#14	Plastic Piping Components & Related Materials
TR-33/2005	Plastic Pipe Institute - Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe

1.04 General

1.04.1 Use

High Density Polyethylene (HDPE) pipes/fittings shall be allowed for use as water, wastewater and reclaimed water pressure pipe where compatible with the specific conditions of the project.

1.04.2 Documentation

1. Documentation from the resin's manufacturer showing results of the following tests for resin identification:

   a. Melt Flow Index ASTM D1238

2. Density ASTM D1505

1.04.3 Manufacturer

All HDPE pipe and fittings shall be from a single manufacturer, who is fully experienced, reputable, and qualified in the manufacture of the HDPE pipe to be furnished. The pipe shall be designed, constructed, and installed in accordance with the best practices and methods and shall comply with these Specifications. Qualified manufacturers shall be: PLEXCO Division of Chevron Chemical Company, DRISCOPIPE as manufactured by Phillips Products Co., Inc., SCLAIRPIPE as manufactured by DuPont of Canada or equal as approved by the Owner's Representative.

1.04.4 Warranty

The pipe MANUFACTURER shall provide a warranty against manufacturing defects of material and workmanship for a period of ten years after the final acceptance of the project by the OWNER. The MANUFACTURER shall replace at no expense to the OWNER any defective pipe/fitting material including labor within the warranty period.

Part 2 Products

2.01 Materials for Pipe Sizes Four-Inch Diameter and Larger

A. Materials used for the manufacture of polyethylene pipe and fittings shall be made from a PE 3408 high density polyethylene resin compound meeting cell classification 345434C per ASTM D3350; and meeting Type III, Class C, Category 5, Grade P34 per ASTM D1238.

B. High Density Polyethylene (HDPE) pipe shall comply with AWWA Specifications C906.

C. If rework compounds are required, only those generated in the Manufacturer's own plant from resin compounds of the same class and type from the same raw material supplier shall be used.

D. Dimensions and workmanship shall be as specified by ASTM F714. HDPE fittings and transitions shall meet ASTM D3261. HDPE pipe shall have a minimum density of 0.955 grams per cubic centimeter. All HDPE pipe and fittings shall have a Hydrostatic Design Basis (HDB) of 1,600 psi.

2.02 FITTINGS

A. All molded fittings and fabricated fittings shall be fully pressure rated to match the pipe SDR pressure rating to which they are made. All fittings shall be molded or fabricated by the manufacturer. No Contractor fabricated fittings shall be used unless approved by the Engineer.

B. The manufacturer of the HDPE pipe shall supply all HDPE fittings and accessories as well as any adapters and/or specials required to perform the work as shown on the Drawings and specified herein.

C. All fittings shall be installed using butt-fused fittings, thermo-fused fittings/couplings, or flanged adapters and must be approved by the Engineer. NO size on size wet taps shall be permitted.

Part 3 Execution

3.01 Joining Method

A. The pipe shall be joined with butt, heat fusion joints as outlined in ASTM D2657 and conform to the Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe, Technical Report TR-33/2005, published by the Plastic Pipe Institute (PPI). All joints shall be made in strict compliance with the manufacturer's recommendations. A factory qualified joining technician as designated by pipe manufacturer or experienced, trained technician shall perform all heat fusion joints in the presence of the Owner's Representative.

B. Lengths of pipe shall be assembled into suitable installation lengths by the butt- fusion process. All pipes so joined shall be made from the same class and type of raw material made by the same raw material supplier. Pipe shall be furnished in standard laying lengths not to exceed 50 feet and no shorter than 20 feet.

3.02 Installation

A. High Density Polyethylene (HDPE) Pipe shall be installed in accordance with the instruction of the manufacturer, as shown on the Drawings and as specified herein. A factory qualified joining technician as designated by the pipe manufacturer shall perform all heat fusion joints.

B. HDPE shall be installed either by Open Trench Construction or direct placement on existing or regraded surface.

C. Care shall be taken in loading, transporting and unloading to prevent damage to the pipe. Pipe or fitting shall not be dropped. All pipe or fitting shall be examined before installation, and no piece shall be installed which is found to be defective. Any damage to the pipe shall be repaired as directed by the Engineer. If any defective pipe is discovered after it has been installed, it shall be removed and replaced with a sound pipe in a satisfactory manner by the contractor, at his own expense.

D. Under no circumstances shall the pipe or accessories be dropped into the trench or forced through a directional bore upon "pull-back".

E. Care shall be taken during transportation of the pipe such that it will not be cut, kinked, or otherwise damaged.

F. Ropes, fabric, or rubber protected slings and straps shall be used when handling pipes. Chains, cables, or hooks inserted into the pipe ends shall not be used. Two slings spread apart shall be used for lifting each length of pipe.

G. Pipes shall be stored on level ground, preferably turf or sand, free of sharp objects, which could damage the pipe. Stacking of the polyethylene pipe shall be limited to a height that will not cause excessive deformation of the bottom layers of pipes under anticipated temperature conditions. Where necessary due to ground conditions, the pipe shall be stored on wooden sleepers, spaced suitably and of such width as not to allow deformation of the pipe at the point of contact with the sleeper or between supports.

H. Pipe shall be stored on clean level ground to prevent undue scratching or gouging. The handling of the pipe shall be in such a manner that the pipe is not damaged by dragging it over sharp and cutting objects. The maximum allowable depth of cuts, scratches, or gouges on the exterior of the pipe is 5 percent of wall thickness. The interior pipe surface shall be free of cuts, gouges, or scratches.

I. Pipe shall be laid to lines and grade shown on the Drawings with bedding and backfill as shown on the Drawings.

J. When laying is not in progress, including lunchtime, the open ends of the pipe shall be closed by fabricated plugs, or by other approved means.

K. Sections of pipe with cuts, scratches or gouges exceeding 5 percent of the pipe wall thickness shall be removed completely and the ends of the pipeline rejoined.

L. The pipe shall be joined by the method of thermal butt fusion, as outlined in PART 3 – Execution, Section 3.01 Joining Method. All joints shall be made in strict compliance with the manufacturer's recommendations.

M. All HDPE pipe must be at the temperature of the surrounding soil at the time of backfilling and compaction.

N. If a defective pipe is discovered after it has been installed, it shall be removed and replaced with a sound pipe in a satisfactory manner at no additional cost to the Owner. All pipe and fittings shall be thoroughly cleaned before installation, shall be kept clean until they are used in the work and when laid, shall conform to the lines and grades required.

-End of Section-

SECTION 02708
Guardrail

SECTION 02708
Guardrail

Part 1 General

1.01 Description

A. The WORK under this Section includes providing all labor, materials, tools, and equipment necessary for furnishing and installing guardrail as shown on the Drawings.

Part 2 Products

2.01 Materials

A. Guardrail components and posts shall conform to the requirements of VDOT Standard Specifications Section 505.02. Guardrail and posts may be reused in accordance with VDOT Standard Specifications Section 505.03.

B. Concrete for anchors shall meet the requirements of Section 03100 – Cast-in-Place Concrete.

Part 3 Execution

3.01 Construction

A. Guardrail construction shall be in accordance with VDOT Standard Specifications Section 505.03, except that a trained guardrail installer shall not be required.

-End of Section-

SECTION 02936
Seeding

Section 02936
Seeding

Part 1 General

1.01 Description

A. Supply all material, labor, equipment required for soil preparations and placement of seeding in location as directed by the Owner's Representative or as shown on the plans. This work shall include maintenance of established seeded areas until final acceptance. The Contractor shall be expected to provide and place all vegetative material necessary to complete the work.

B. Apply lime, fertilizer, seed, and seed mulch to all areas disturbed by the work not receiving a specific surfacing.

1.02 Requirements of Regulatory Agencies

Pesticides, herbicides, and fungicides shall be used in accordance with the specifications of the prevailing Public Health Authority or Agricultural Extension Service.

1.03 Related Work

A. Erosion and Sedimentation Control

B. Vegetative Layer

1.04 Submittals

A. Submit full and complete information on vegetative support layer material sampling and fertility testing results prior to amending vegetative material with lime and fertilizer.

B. Submit to the Owner's Representative affidavits certifying that seed comply with the specifications.

C. Submit Flexible Growth Medium or hydroseed procedure and application rates for approval by Owner's Representative.

D. Submit full and complete written maintenance instructions for proper care and development of seeded areas to Owner prior to substantial completion.

E. Submit material certification for seed mulch to the Owner's Representative.

F. Submit recommendation from certified agriculturalist for type and rate of seeding and rate of lime application based on testing of vegetative support layer material.

G. Seeding shall be limited to grasses and other shallow-rooted plants. Vegetation may not include trees, shrubs, or other plants with deep woody roots that may penetrate the geomembrane.

1.05 Product Handling

Deliver seed, lime, and fertilizer in new, clean, sealed containers.

1.06 Scheduling

A. Schedule planting of permanent seeding areas for optimum germination as follows:

1. Spring planting schedule is March 15th to June 15th.

2. Fall planting schedule is August 15th to October 15th.

B. Seeding dates other than listed above are to be approved by the Owner.

1.07 References

A. Virginia Erosion and Sediment Control Handbook (VESCH), Third Edition, 1992.

Part 2 Products

2.01 Fertilizer

The fertilizer shall be as indicated on the Drawings or by certified agronomist.

2.02 Seed

A. Seed shall be brought on site unmixed unless the mixture is certified and stated on the package as to the quality and mixture. Mixing shall be done at the project site from the original unopened packages. Unless otherwise indicated from soil-specific analysis, seed mixtures and application rates shall be as shown on the Drawings. Sericea lespedeza is prohibited from use at this site. Kentucky 31 Tall Fescue, Red Top Grass, and Common Bermuda Grass are prohibited in Resource Protection Areas (RPA) and RPA mitigation Areas.

B. Seed shall be certified as described in VESCH Standard and Specification 3.32. Seed quality shall be in accordance with VESCH Table 3.32E.

2.03 Agricultural Ground Dolomitic Limestone

A. Agricultural ground dolomitic limestone shall conform to the standards of the Association of Official Agricultural Chemists, and must comply with all existing State and Federal regulations.

B. The material must comply with the following gradation or recommendations of certified agronomist:

Square Mesh Sieves	Percent Passing by Weight
Pass # 10	100
Pass # 20	90
Pass # 100	40

C. The minimum calcium carbonate equivalent shall be 90.

D. The Owner reserves the right to draw such samples and perform such tests as he deems necessary to assure that these Specifications are met.

2.04 Seed Mulch

A. Provide erosion control or hydromulch as required in areas to be seeded.

B. Seed mulch shall be as indicated on the Drawings and in accordance with VESCH Standard and Specification 3.35.

Part 3 Execution

3.01 General

Sample vegetative support layer source material and obtain recommendation for seeding and soil amendments from a certified agronomist. Soil amendments and construction methods shall be those established as agronomically acceptable and feasible and which are approved by the Owner's Representative. Depending on the organic content of the proposed vegetative support soil, compost may be required to amend the vegetative support soil.

3.02 Seed Bed Preparation

A. Surfaces to receive seed shall be prepared in accordance with VESCH Standard and Specification 3.29, Surface Roughening. The areas shall be scarified and made friable and receptive to seeding by approved methods, which will not disrupt the line and grade of the slope surface. In no event will seeding be permitted on hard or crusted soil surface.

B. The finished surface shall be free from lumps or stones 6 inches or more in any dimension. Installation of grass areas may be done immediately after finish grading provided the seeding bed is in a good condition and not muddy or hard. If it is hard, loosen or roughen to a friable condition again. Loosening and roughening the soil shall be performed without damaging underlying geosynthetics.

3.03 Applying Lime, Fertilizer, Seed

A. Seed areas within the areas disturbed by Contractor as directed by the Owner's Representative and Contract Drawings. After cleaning the seeding area of coarse material, maintain finish grades as shown on the Contract Drawings and spread fertilizer and lime uniformly over the areas using an approved mechanical spreader. The rate of application of fertilizer shall be as indicated on the Drawings or by soil test results.

B. The lime application rates shall be as indicated on the Drawings but may be modified based on fertility test results. Lime shall be broadcasted to achieve a soil pH range between 6.0 and 7.0. Lime and fertilizer shall be incorporated into the soil by discing or other approved method as indicated on the Drawings.

C. Do not undertake seeding in windy or unfavorable weather or when the ground is too wet to rake easily, frozen, or too dry.

D. Apply seed uniformly with a broadcast spreader, drill, culti-packer seeder, or hydroseeder. Seeding depth should be ¼ to ½ inch.

E. To avoid poor germination rates as a result of seed damage during hydroseeding, if a machinery breakdown of 30 minutes to 2 hours occurs, 50 percent more seed shall be added to the tank, based on the proportion of slurry remaining in the tank. Beyond 2 hours, a full rate of new seed shall be provided and applied.

3.04 Replanting and Maintenance

A. The Contractor shall be required to replant areas damaged by water, wind, fire, equipment or pedestrian traffic as necessary or when ordered by the Owner at no cost to the Owner.

B. All areas and spots that do not show a prompt catch of vegetation shall be reseeded at 15-day intervals until a growth of grass is established.

C. Contractor shall reseed as required to establish a minimum of 95 percent vegetation coverage within one year of initial planting. Contractor shall maintain seeded areas for a minimum of 1 year after vegetation if established and accepted by the Owner's

Representative. Maintenance, remedial seeding, fertilizer, and lime will be applied at no additional cost to the Owner.

3.05 Compaction

The Contractor shall keep all equipment and vehicular and pedestrian traffic off areas that have been seeded to prevent excessive compaction and damage to young plants. Where such compaction has occurred, the Contractor shall rework the soil to make a suitable seedbed; then reseed and reblanket such areas with the full amounts of the specified materials, at no extra expense to the Owner.

3.06 Mulching

A. If seeding is done with hydromulching, then seeding mixture shall be increased 10 percent.

B. Hydromulching of seeding areas shall have approved mulch applied at a rate as recommended by the manufacturer for tacking agent.

C. Mulch applied in a separate application from seeding shall be applied within 48 hours after completion of the seeding operation.

D. Other methods of mulching shall not be applied prior to approval by the Owner's Representative.

E. Mulch rates shall be as indicated on the Drawings.

3.07 Maintenance of Grass Areas

A. Water, weed, and reseed throughout the construction contract and/or acceptance by the Owner's Representative after seeding areas are substantially established turf areas.

B. Install and maintain temporary protection fences, barriers, and signs where deemed necessary.

-End of Section-

SECTION 03000
Chain Link Fence and Gates

Section 03000
Chain Link Fence and Gates

Part 1 General

1.01 Summary

A. This Section includes industrial/commercial chain link fence and gates specifications:

1. Zinc-5% Aluminum alloy coated steel chain link fabric
2. Galvanized steel framework and fittings
3. Gates: swing and cantilever slide
4. Barbed wire
5. Installation

B. Related Sections:

1. Earthwork - 02200
2. Seeding - 02936
3. Cast-in-Place Concrete - 03100

1.02 References

A. ASTM International (ASTM) A121 Specification for Metallic-Coated Carbon Steel Barbed Wire

B. ASTM A392 Specification for Zinc-Coated Steel Chain-Link Fence Fabric

C. ASTM A780 Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

D. ASTM A824 Specification for Metallic-Coated Steel Marcelled Tension Wire for Use With Chain Link

E. ASTM F552 Standard Terminology Relating to Chain Link Fencing

F. ASTM F567 Standard Practice for Installation of Chain Link Fence

G. ASTM F626 Specification for Fence Fittings

H. ASTM F900 Specification for Industrial and Commercial Swing Gates

I. ASTM F1043 Specification for Strength and Protective Coatings of Steel Industrial Chain Link Fence Framework

J. ASTM F1083 Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures

1.03 Submittals

A. Certifications: The Contractor shall submit manufacturer's material certifications in compliance with the current ASTM specifications.

B. Domestic certifications: The Contractor shall submit material certifications, Made in U.S.A., Buy American Act or Buy America when required.

1.04 Quality Assurance

A. Fence contractor: Company with demonstrated successful experience installing similar projects and products in accordance with ASTM F567 having at least 5 years' experience.

B. Tolerances: Current published edition of ASTM specifications tolerances apply. ASTM specification tolerances supersede any conflicting tolerance.

1.05 Delivery, Storage, and Handling

A. Delivery: Deliver products to site.

B. Storage: Store and protect products off the ground.

Part 2 Products

2.01 Chain Link Fabric

Steel Chain Link Fabric: Height or heights indicated on drawings, shall be 8 feet tall, with 2-inch mesh, Class 1(1.02 oz/ft^2) zinc coated steel fabric per ASTM A392 hot dipped galvanized before weaving.

2.02 Round Steel Pipe Fence Framework

Round steel pipe and rail: Schedule 40 standard weight pipe, in accordance with ASTM F1083, 1.8 ounces per square foot (oz/ft^2) (550 g/m^2) hot dip galvanized zinc exterior and 1.8 oz/ft^2 (550 g/m^2) hot dip galvanized zinc interior coating

Regular Grade: Minimum steel yield strength 30,000 pounds per square inch (psi) (205 MPa)

1. Line post: 2.375 outside diameter (OD), zinc coated, 3.65 pounds per foot (lb./ft.)
2. End, Corner, Pull post: 2.875 OD, zinc coated, 5.79 lb./ft.
3. Top, brace, bottom, and intermediate rails, 1.660-inch OD: zinc coated, 2.27 lb./ft.

2.03 Tension Wire

Metallic Coated Steel Marcelled Tension Wire: 7 gauge (0.177-inch) (4.50 millimeters) marcelled wire complying with ASTM A824, Type II Zinc-Coated, ASTM A817 Class 4 - 1.2 oz/ft^2.

2.04 Barbed Wire

Metallic Coated Steel Barbed Wire: Comply with ASTM A121, Design Number 12-4-5-14R, double 12.5 gauge 0.099-inch twisted strand wire, with 4 point 14 gauge 0.080-inch round barbs spaced 5 inches on center. Coating Type Z - Zinc-coated: Strand wire coating Type Z, Class 3, 0.80-oz/ft^2, barb coating 0.70-oz/ft^2.

2.05 Fittings

A. Tension and Brace Bands: Galvanized pressed steel complying with ASTM F626, minimum steel thickness of 12 gauge (0.105-inch), minimum width of 0.75-inch and minimum zinc coating of 1.20 oz/ft^2. Secure bands with 0.3125-inch galvanized steel carriage bolts.

B. Terminal Post Caps, Line Post Loop Tops, Rail, and Brace Ends, Boulevard Clamps, Rail Sleeves: In compliance to ASTM F626, pressed steel galvanized after fabrication having a minimum zinc coating of 1.20 oz/ft^2.

C. Truss Rod Assembly: In compliance with ASTM F626, 0.375-inch diameter steel truss rod with a pressed steel tightener, minimum zinc coating of 1.2 oz/ft^2, assembly capable of withstanding a tension of 2,000 pounds.

D. Tension Bars: In compliance with ASTM F626. Galvanized steel one-piece length 2 inches (50 millimeters) less than the fabric height. Minimum zinc coating 1.2 oz/ft^2. Bars shall have a minimum cross section of 0.1875-inch by 0.75-inch.

E. Barbed Wire Arms: In compliance with ASTM F626, pressed steel galvanized after fabrication, minimum zinc coating of 1.20 oz/ft^2, capable of supporting a vertical 250 pound load. Type I – three strand 45 degree arm.

2.06 Tie Wire and Hog Rings

Tie Wire and Hog Rings: Galvanized minimum zinc coating 1.20 oz/ft^2, 9 gauge (0.148-inch) steel wire in compliance with ASTM F626.

2.07 Swing Gates

Swing Gates: Galvanized steel pipe welded fabrication in compliance with ASTM F900. Gate frame members 1.900-inch OD ASTM F 1083 schedule 40 galvanized steel pipe. Frame members spaced no greater than 8 feet apart vertically and horizontally. Welded joints protected by applying zinc-rich paint in accordance with ASTM Practice A780. Positive locking gate latch, pressed steel galvanized after fabrication. Galvanized malleable iron or heavy gauge pressed steel post and frame hinges. Provide lockable drop bar and gate holdbacks with double gates. Match gate fabric to that of the fence system. Gateposts per ASTM F1083 schedule 40 galvanized steel pipe. 4.000-inch OD. 9.11 lb./ft.

2.08 Concrete

Concrete for post footings shall have a 28-day compressive strength of 2,500 psi.

Part 3 Execution

3.01 Clearing Fence Line

Clearing: Surveying, clearing, grubbing, grading and removal of debris for the fence line or any required clear areas adjacent to the fence is included in Prepared Subgrade, and Cover Soil Layer contractor's contract. The contract drawings indicate the extent of the area to be cleared and grubbed.

3.02 Framework Installation

A. Posts: Posts shall be set plumb in concrete footings in accordance with ASTM F567. Minimum footing depth, 36 inches. Minimum footing diameter shall be 16 inches. Top of concrete footing shall be crowned to shed water away from the post. Line posts installed at intervals not exceeding 10-foot on center.

B. Top rail: Install 21-foot lengths of rail continuous thru the line post or barb arm loop top. Splice rail using top rail sleeves minimum 6 inches long. Rail shall be secured to the terminal post by a brace band and rail end. Bottom rail or intermediate rail shall be field cut and secured to the line posts using boulevard clamps or brace band with rail end.

C. Terminal posts: End, corner, pull, and gate posts shall be braced and trussed. The horizontal brace rail and diagonal truss rod shall be installed in accordance with ASTM F567.

D. Tension wire: Shall be installed 4 inches from the bottom of the fabric. Tension wire to be stretched taut, independently and prior to the fabric, between the terminal posts and secured to the terminal post using a brace band. Secure the tension wire to each line post with a tie wire.

3.03 Chain Link Fabric Installation

Chain Link Fabric: Install fabric to inside of the framework. Attach fabric to the terminal post by threading the tension bar through the fabric; secure the tension bar to the terminal post with tension bands and 0.3125-inch carriage bolts spaced no greater than 12 inches on center. Chain link fabric to be stretched taut free of sag. Fabric to be secured to the line post with tie wires spaced no greater than 12 inches on center and to horizontal rail spaced no greater than18 inches on center. Secure fabric to the tension wire with hog rings spaced no greater than 18 inches on center. Tie wire shall be wrapped around the post or rail and attached to the fabric wire picket on each side by twisting the tie wire around the fabric wire picket two full turns. Excess wire shall be cut off and bent over to prevent injury. The installed fabric shall have a ground clearance on no more than 2 inches.

3.04 Barbed Wire Installation

Barbed Wire: Stretched taut between terminal posts and secured in the slots provided on the line post barb arms. Attach each strand of barbed wire to the terminal post using a brace band. Barb arm shall be Type I and direction inward.

3.05 Gate Installation

Swing Gates: Installation of swing gates and gateposts in compliance with ASTM F 567. Direction of swing shall be outward. Gates shall be plumb in the closed position having a bottom clearance of three inches, grade permitting. Hinge and latch offset opening space shall be no greater than three inches in the closed position. Double gate drop bar receivers shall be set in a concrete footing minimum six-inch diameter 24 inches deep. Gate leaf holdbacks shall be installed for all double gates.

3.06 Nuts and Bolts

Bolts: Carriage bolts used for fittings shall be installed with the head on the secure side of the fence. All bolts shall be peened over to prevent removal of the nut.

3.07 Clean Up

Clean Up: The area of the fence line shall be left neat and free of any debris caused by the installation of the fence.

-End of Section-

SECTION 03100
Cast-In-Place Concrete

Section 03100
Cast-In-Place Concrete

Part 1 General

1.01 Description of Work

Furnish and install miscellaneous cast-in-place concrete as shown and indicated on the Contract Drawings and as specified in this Section. This specification does not include structural concrete as in bridge or roadway uses.

1.02 Related References

A. The latest edition of the publications listed below form a part of these Specifications:

1. American Concrete Institute (ACI) Publications:

211.1	Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
304	Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete
305R	Hot Weather Concreting
306R	Cold Weather Concreting

2. United States Army Corps of Engineers Waterways Experiment Station Publication CRD-C-621: Handbook for Concrete and Cement, Specifications for Non-shrink Grout, Volume II
3. American Association of State Highway and Transportation Officials Publication M 182 Burlap Cloth Made From Jute or Kenaf
4. ASTM International (ASTM) Publications:

C 31	Making and Curing Concrete Test Specimens in the Field
C 33	Concrete Aggregates
C 39	Compressive Strength of Cylindrical Concrete Specimens
C 94	Ready-Mixed Concrete
C 143	Slump of Portland Cement Concrete
C 150	Portland Cement
C 172	Sampling Freshly Mixed Concrete
C 173	Air Content of Freshly Mixed Concrete by the Volumetric Method
C 231	Air Content of Freshly Mixed Concrete by the Pressure Method
C 260	Air-Entraining Admixtures for Concrete
C 494	Chemical Admixtures for Concrete
C 595	Blended Hydraulic Cements

1.03 Submittals

A. Contractor shall be responsible for timely submittals to the Owner's Representative.

B. The following submittals shall be provided for filling/plugging the Pond D outlet pipe:

1. Filling Plan. A plan detailing the Contractor's concrete mix equipment, setup, procedure, sequencing, plan for handling waste, method for communication, and

method for sealing and bulkheading upstream and downstream should be submitted to the Owner's Engineer prior to initiation of the filling operations. The watertight bulkhead must be capable of resisting the loads from the grout or concrete.

2. Concrete Mixtures. Documentation of adequate strength and flow from the planned mixture should be submitted to the Owner's Engineer prior to initiation of the filling operations.

Part 2 Products

2.01 Cement

Cement shall be standard Portland cement of American manufacture, conforming to ASTM C 150, Type I. Only one brand of commercial Portland cement shall be used in the exposed concrete of the structure. Cement reclaimed by cleaning bags or from leaking containers shall not be used.

2.02 Concrete Aggregates

A. Fine aggregate shall be sand having clean, hard, durable, uncoated grains and free from deleterious substances and shall conform to ASTM C 33.

B. Coarse aggregate shall be crushed stone having clean, hard, durable, uncoated particles conforming to ASTM C 33.

2.03 Water

Water used in mixing concrete shall be clean, potable, and free from deleterious amounts of acids, alkalis, or organic materials.

2.04 Admixtures

A. Water reducing admixture shall conform to ASTM C 494, Type A.

B. Water reducing, retarding admixture shall conform to ASTM C 494, Type D.

C. Non-Corrosive, Non-Chloride Accelerator: The admixture shall conform to ASTM C 494, Type C.

D. Air entraining admixture shall conform to ASTM C 260.

E. High range water reducer (HRWR) shall conform to ASTM C494, Type F or G.

F. Calcium Chloride: Calcium chloride or admixtures containing more than 0.1 percent chloride ions are <u>not</u> permitted.

Part 3 Execution

3.01 Concrete Quality

A. Mix designs other than pipe filling concrete shall be proportioned in accordance with ACI 211.1. The proportioning shall be based on the requirements of a well-graded high density plastic and workable mix within the slump range and strengths required. The following class of concrete is required:

Class of Concrete	Compressive Strength at 28 Days	Slump Range
Virginia Department of Transportation A4	3,000 pounds per square inch	2 to 4 inches

1. Air Content: All concrete shall have an air content of 6.5 percent, +/- 1.5 percent.
2. Water-Cement Ratio: All concrete shall have a maximum water-cement ratio of 0.45.
3. Admixture Usage: All concrete shall contain a water reducing admixture or water reducing-retarding admixture, and an air entraining agent. All concrete placed at air temperatures below 50°F shall contain the specified non-corrosive non-chloride accelerator.

B. Concrete for filling the outlet pipe shall be a non-shrink mix proportioned to provide a slump of about 6 to 7 inches and a compressive strength of 3,000 pounds per square inch at 28 days.

The mix shall have a water to cement ratio of 0.7:1 to 0.5:1. A grout fluidifier (ASTM C937) may be needed to promote flowability, reduce water requirements, reduce bleeding, reduce segregation, increase strength, and eliminate grout shrinkage during setting of the grout mix.

3.02 Plant Mixing

A. Proportioning Concrete

1. Proportions shall be in compliance with approved design mix for each class of concrete.
2. The mixing plant shall be provided with adequate equipment and facilities for accurate measurement and control of the quantities of material and water used in the concrete.
3. Concrete materials shall be measured by weight except that admixtures shall be measured by volume.

B. Batching

1. Ready-mixed concrete shall be mixed and delivered in accordance with requirements of ASTM C 94 and to the following:
    a. A separate water metering device (not truck tank) shall be used for measuring water added to the original batch.
    b. Use of wash water as a portion of the mixing water is not permitted. Wash water added to empty drums after discharging shall be dumped before a new batch is received.
    c. Centrally mixed concrete shall be mixed for the length of time specified herein, not "shrink-mixed".
    d. Mixing drums shall be watertight.
    e. Concrete shall be discharged within one and a half hours from the time concrete was mixed, if centrally mixed, or from time the original water was added, if transit-mixed.
    f. Furnish delivery ticket with each load of concrete delivered under these Specifications. Delivery ticket shall show clearly the class and strength of concrete, size of coarse aggregate, water per cubic yard, the slump

ordered, quantities of all admixtures, and the date and time of departure from the batching plant.

3.03 Conveying Equipment

A. If concrete is to be transported in carts or buggies, the carts or buggies shall be equipped with pneumatic tires.

B. Equipment for chuting or other methods of conveying concrete shall be of such size and design as to insure a practically continuous flow of concrete at delivery without segregation of materials.

3.04 Delivery and Protection of Materials

Deliver ready-mixed concrete in compliance with requirements set forth in ASTM C 94.

3.05 Severe-Weather Provisions

A. Hot-Weather Concreting

1. Provide adequate methods of lowering temperature of concrete ingredients so that the temperature of concrete when placed does not exceed 90°F.
2. When the weather is such as to raise concrete temperature, as placed, consistently above 90°F, Pozzolith retarder shall be used.
3. Subgrade and forms shall be wetted with water before placing of concrete. All excess water shall be removed before concrete is placed.
4. Curing shall start as soon as practicable to prevent evaporation of water. Flat work shall be protected from dry winds, direct sun, and high temperatures.

B. Cold-Weather Concreting

1. Provide adequate equipment for heating concrete materials and protecting concrete during freezing or near-freezing weather. No frozen materials, or materials containing ice, shall be used.
2. All concrete materials and all reinforcement, forms, fillers and ground with which concrete is to come into contact shall be free from frost.
3. Whenever the temperature of the surrounding air is below 40°F and falling, all concrete placed in the forms shall have a temperature of between 70 and 80°F, and adequate means shall be provided for maintaining a temperature of not less than 70°F for 3 days, or 50°F for 5 days, or for as much more time as is necessary to insure proper curing of the concrete. If high early strength concrete is used, the requirement for maintenance of 50°F can be reduced to 3 days.
4. Use only the specified non-chloride accelerator. Calcium chloride or admixtures containing more than 0.1 percent chloride ions are not permitted.
5. Housing, covering, or other protection used in connection with curing shall remain in place and intact at least 24 hours after the artificial heat is discontinued.

3.06 Placing

A. Deposit concrete as nearly as practicable in its final position to avoid segregation due to re-handling or flowing. Do not deposit concrete on work that has partially hardened or been contaminated by foreign material, and do not use re-tempered concrete.

B. Concrete shall not be dropped more than 4 feet. For greater distances of drop, concrete shall be handled with metal chutes or tremie pipes.

C. Concrete shall be placed in layers not over 12 inches deep and each layer shall be compacted with the aid of mechanical internal-vibrating equipment supplemented by hand spading. Vibrators shall in no case be used to transport concrete. Use of form vibrators will not be permitted. Internal vibrators shall maintain a speed of not less than 5,000 impulses per minute when submerged in the concrete. At least one spare vibrator shall be maintained as a relief. Provide backup power source. Duration of vibrator use shall be limited to that necessary to produce satisfactory consolidation without causing objectionable segregation. Vibrator shall not be lowered into courses that have begun to set. Apply vibrator at uniformly spaced points not further apart than the visible effectiveness of the machine.

D. Foundations shall be Seced and the concrete deposited in the dry.

E. Outlet Pipe Filling

   1. Remaining outlet pipe shall be filled after Phase 3 grading has been established but prior to placement of CCM.

   2. Prior to filling the pipe shall be inspected for the existence of voids, protrusions, or obstructions. The Contractor shall use a camera to complete a video inspection of the outlet pipe.

   3. The existing conduit surfaces against which grout will be placed shall be free of roots, sediments, mineral deposits, loose or defective concrete, and other foreign materials. Any sediment or debris should be removed.

   4. The downstream end of the pipe shall be sealed with a watertight bulkhead capable of resisting the loads from the grout or concrete.

   5. Grouting equipment should be capable of continuously pumping grout at any pressure up to 50 pounds per square inch. Injection pipes for concrete should be about 5 inches in diameter.

   6. Concrete shall be placed such that air will not be trapped in the pipe. Tremie or alternate method should be used to distribute the grout in the outlet pipe.

   7. After the concrete has set, the bulkhead(s) shall be removed, as appropriate.

-End of Section-

SECTION 03301
Sanitary Utility Sewerage Force Main Testing

Section 03301
Sanitary Utility Sewerage Force Main Testing

Part 1 General

1.01 Summary

A. Contractor shall furnish all supervision, labor, products, equipment, and tools, including all necessary and incidental items as detailed or required, to test sanitary sewerage force main in accordance with the Drawings, Specifications, and project Construction Quality Assurance (CQA) Plan.

B. If differences exist between the drawings and specifications, the stricter shall apply.

1.02 Reference Standards

A. American Water Works Association (AWWA), latest revision:

B. AWWA C605 - Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented PVC Pressure Pipe and Fittings.

1.03 Submittals

A. Contractor shall be responsible for timely submittals to the Owner's Representative and Owner.

B. Submit following items prior to start of testing:

1. Testing procedures.
2. List of test equipment.
3. Testing sequence schedule.
4. Provisions for disposal of flushing and test water.
5. Certification of test gage calibration.

C. Test and Evaluation Reports: Indicate results of piping tests.

Part 2 Products

2.01 Hydrostatic Testing

A. Equipment:

1. Hydro pump.
2. Pressure hose.
3. Water meter.
4. Test connections.
5. Pressure relief valve.
6. Pressure Gage: Calibrated to 0.1 psi (0.69 kPa).

Part 3 Execution

3.01 Examination

A. Verify that piping are ready for testing.

B. Verify that trenches are backfilled.

C. Verify that pressure piping thrust restraint system is installed.

3.02 Preparation

A. Valves:

1. Verify isolation valves are closed.

3.03 Field Quality Control

A. Testing of Pressure Piping:

1. Test system according to AWWA C605 and following:

a. Hydrostatically test each portion of pressure piping, including valved section, at 1.5 times working pressure of piping or 150 psi, whichever is greater, based on elevation of lowest point in piping corrected to elevation of test gage.

b. Conduct hydrostatic testing for at least two hours.

c. Slowly fill with water portion of piping to be tested, expelling air from piping at high points.

d. Install corporation cocks at high points.

e. Close air vents and corporation cocks after air is expelled.

f. Raise pressure to specified test pressure.

g. Remove and renew cracked pipes, joints, fittings, and valves that show visible leakage.

h. Retest.

i. Correct visible deficiencies and continue testing at same test pressure for additional two hours to determine leakage rate.

j. Maintain pressure within plus or minus 5.0 psi (34.4 kPa) of test pressure.

k. Leakage is defined as quantity of water supplied to piping necessary to maintain test pressure during period of testing.

l. Compute maximum allowable leakage using following formula:

i. L = [SD x sqrt(P)]/C.
ii. L = testing allowance, gph (L/h).
iii. S = length of pipe tested, feet (m).
iv. D = nominal diameter of pipe, inches (mm).
v. P = average test pressure during hydrostatic testing, psig (kPa).
vi. C = 148,000 (794,797).

vii. If pipe undergoing testing contains sections of various diameters, calculate allowable leakage from sum of computed leakage for each pipe size.

2. If testing of piping indicates leakage greater than that allowed, locate source of leakage, make corrections, and retest until leakage is within acceptable limits.

3. Correct visible leaks regardless of quantity of leakage.

-End of Section-

SECTION 03334
Sanitary Utility Sewerage Force Mains

Section 03334
Sanitary Utility Sewerage Force Mains

Part 1 General

1.01 Summary

A. Contractor shall furnish all supervision, labor, products, equipment, and tools, including all necessary and incidental items as detailed or required, to install sanitary sewerage force main in accordance with the Drawings, Specifications, and project Construction Quality Assurance (CQA) Plan.

B. If differences exist between the drawings and specifications, the stricter shall apply.

1.02 Reference Standards

A. American Association of State Highway and Transportation Officials (AASHTO):

1. AASHTO T180 - Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. American Water Works Association, latest revisions:

1. American Water Works Association (AWWA) C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
2. AWWA C110 - Ductile-Iron and Gray-Iron Fittings.
3. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
4. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. through 12 In. (100 mm through 300 mm), for Water Transmission and Distribution.
5. AWWA C605 - Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented PVC Pressure Pipe and Fittings.

C. ASTM International (ASTM):

1. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3).
2. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3).
3. ASTM D2241 - Standard Specification for PVC Pressure-Rated Pipe (SDR Series).
4. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

D. Ductile Iron Pipe Research Association:

1. Thrust Restraint Design for Ductile Iron Pipe.

1.03 Coordination

A. Coordinate Work of this Section with Owner's Representative and Prince William County Service Authority.

1.04 Submittals

A. Contractor shall be responsible for timely submittals to the Owner's Representative.

B. The following submittals shall be provided:

1. Product Data: Submit manufacturer information indicating pipe material used, pipe accessories, valves, restrained joint details, and materials.
2. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
3. Manufacturer Instructions: Indicate special procedures and tools required to install specified products.
4. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
5. Qualifications Statements:
   a. Submit qualifications for manufacturer, installer, and licensed professional.
   b. Submit manufacturer's approval of installer.

1.05 Closeout Submittals

A. Project Record Documents: Record invert elevations and actual location of pipe runs and connections.

B. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.06 Construction Quality Assurance

A. Perform Work according to latest revision of American National Standards Institute (ANSI) /AWWA standards.

B. Maintain 1 copy of each standard affecting Work of this Section on Site.

1.07 Delivery, Storage, and Handling

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Storage:

1. Store materials according to manufacturer instructions.
2. Do not place materials on private property without written permission of property owner.
3. Do not stack pipe higher than recommended by pipe manufacturer.

C. Protection:

1. Protect all materials from vandalism and theft.
2. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
3. Store gaskets for mechanical and push-on joints in cool and dry location, out of direct sunlight, and not in contact with petroleum products.

4. Provide additional protection according to manufacturer instructions.
5. Provide freeze protection during cold weather.

1.08 Existing Conditions

A. Field Measurements:
   1. Verify field measurements prior to fabrication.
   2. Indicate field measurements on Shop Drawings.

B. Utilities:
   1. Call Virginia 811 "one call" (800-552-7001) prior to earthwork activities.
   2. Field verify existing utilities.
   3. Notify Owner's Representative of any conflicts.

Part 2 Products

2.01 Force Main

A. PVC Pressure Sewer Pipe and Fittings, 12-Inch (300-mm) Nominal Size and Smaller:
   1. Comply with AWWA C900.
   2. Class 235.
   3. Joints: Push On.

B. Ductile-Iron Fittings:
   1. Comply with AWWA C110.
   2. Pressure Rating: 250 psig.
   3. Cement mortar lined and outside coated.
   4. Joints:
      i. Comply with AWWA C111.
      ii. Type: Mechanical.
   5. Rubber Gaskets, Lubricants, Glands, Bolts, and Nuts: Comply with AWWA C111.

C. Plug Valves:
   1. Comply with AWWA C517.
   2. Pressure Rating: 250 psig.
   3. Inside and outside epoxy coated.
   4. Joints:
      i. Comply with AWWA C111.
      ii. Type: Mechanical.
   5. Rubber Gaskets, Lubricants, Glands, Bolts, and Nuts: Comply with AWWA C111.

D. Restraint: Thrust blocks or retainer glands per Drawings.

   1. EBAA Iron Series 1500 or approved equal for push on joints.
   2. EBAA Iron Series 1100 Megalug or approved equal for plain end connections to mechanical joint ductile iron fittings.

2.02 Bedding and Cover

A. Bedding: Fill Type as specified in Drawings.

B. Cover: Fill Type as specified in Drawings.

C. Soil Backfill from above Pipe to Finish Grade: Soil Type as specified in Drawings.

D. Subsoil: No rocks more than six inches (150 mm) in diameter, frozen earth, or foreign matter.

2.03 Mixes

A. Concrete: As specified in Drawings and Section 03100.

Part 3 Execution

3.01 Examination

A. Contractor is responsible for site safety in accordance with Section 01000.

B. Verify that trench cut is ready to receive Work and complies with Occupational Safety and Health Administration requirements.

C. Verify that excavations, dimensions, and elevations are as indicated on Drawings.

3.02 Preparation

A. Correct over-excavation with coarse aggregate.

B. Remove large stones or other hard matter capable of damaging pipe or of impeding consistent backfilling or compaction.

3.03 Installation

A. Bedding:

   1. Excavate pipe trench as specified in Drawings.
   2. Install piping level or with continuous positive slope to existing air release vault.
   3. Place bedding material at trench bottom.
   4. Level materials in continuous layers not exceeding 6inches in depth.
   5. Maintain optimum moisture content of bedding material to attain required compaction density.

B. Piping:

   1. Install pipe, fittings, and accessories as indicated on Drawings.
   2. Route piping in straight line.
   3. Install bedding at sides and over top of pipe as indicated on Drawings.
   4. Backfilling and Compacting:

a. As specified in Drawings.

b. Do not displace or damage pipe while compacting.

5. Installation Standards: Install Work according to ANSI/AWWA standards.

C. Thrust Restraints:

1. Provide pressure pipeline with restrained joints or concrete thrust blocking at bends, tees, and changes in direction.

2. Construct concrete thrust blocking as indicated on Drawings.

3.04 Field Quality Control

A. Inspections: Request inspection by Owner's Representative prior to placing bedding.

B. Testing:

1. If tests indicate that Work does not meet specified requirements, remove Work, replace, and retest.

2. Pipe Testing:

a. Pressure Test: As specified in Section 330130.13 - Sanitary Utility Sewerage Forcemain Testing.

3.05 Protection

A. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

-End of Section-

SECTION 03346
Corrugated Plastic Pipe

SECTION 03346
Corrugated Plastic Pipe

Part 1 General

1.01 Description of Work

The Contractor shall furnish all labor, materials, equipment, tools, and appurtenances required to complete the work of furnishing, placing and compacting the stone as shown, specified or required. Contractor shall implement and supervise all work.

1.02 Related Sections

A. Drain Gravel /Coarse Aggregate

B. Nonwoven Filter Geotextile

C. Geocomposite Drainage Net

1.03 Submittals

The Contractor shall submit manufacturer's technical data, including cut sheets, standard specifications, and manufacturing information for all perforated and solid pipe and fittings.

1.04 Quality Assurance

A. Pipe installation shall be performed by skilled workers. Each pipe laying crew shall have a pipe laying foreman.

B. Pipe shall be accurately installed to the lines and grades shown on the Construction Drawings, or as approved by the Owner's Representative, so that inverts are smooth.

C. Deflections in horizontal alignment at joints are not permitted without the written consent of the Owner's Representative. If so approved, the deflections shall not exceed one-half the manufacturer's recommendation.

D. The Owner's Representative shall be notified in advance whenever an existing pipeline location conflicts with the proposed locations of the Work.

E. Pipe and fittings of the same type shall be the products of a single manufacturer.

F. All piping shall be of the type and size as shown on the Construction Drawings and described in herein.

1.05 Delivery, Storage, and Handling

A. All pipes and fittings shall be carefully handled when loading and unloading. Lift by hoists or lower on skidways in a manner to avoid shock.

B. Where required, due to weight of material and for the safety and protection of workmen, materials, equipment, property, and the work, use derricks, ropes, or other suitable equipment for lowering pipe into trenches. Take particular care to avoid damaging the pipe.

C. Pipe and fittings shall be protected against the damaging ultraviolet rays of the sun when stored for any period. Such protection shall consist of canvas covering, or other material as recommended by the manufacturer. Plastic sheets shall not be used which may allow excessive temperatures to develop where pipe is stored. All pipe which has been distorted or otherwise negatively affected by high temperatures shall be rejected, regardless of the pipe's appearance after return to ambient temperatures. Rejected pipe shall be marked by the QC Team and removed from the site of the work at the sole expense the Contractor.

D. The manufacturer's recommended procedures for pipe stacking shall be followed. When pipe is stacked for storage, the heaviest series of pipe shall be placed at the bottom.

E. Pipe and fittings shall be protected from damage by sharp objects through all phases of work.

F. If any defective pipe is discovered after being laid or placed, removal and replacement with a sound pipe will be required without cost to the Owner.

Part 2 Products

2.01 Pipe and Fittings

A. The HDPE Corrugated Plastic Pipe (CPP) shall have a nominal inside diameter as shown and shall have external corrugations with an integrally formed smooth interior surface (Advanced Drainage Systems N-12 Pipe or approved equivalent).

B. The pipe shall meet the requirements of AASHTO designations M-252 Type S (4 to 10 inch pipe) or M-294 (12 to 60 inch) Type S.

C. The CPP pipe and any HDPE pipe fittings shall be composed of polyethylene compounds meeting the requirements of ASTM D 1248 for Type III, Category 4 or 5, Grade P33 or P34 polyethylene. Clean reworked material may be used.

D. The minimum parallel plate pipe stiffness shall be 34 psi as measured by ASTM D 2412.

E. The pipe and fittings shall be free of foreign inclusions and visible defects. The pipe perforations shall be as indicated on the Drawings. The ends shall be cut squarely so as not to adversely affect joining.

F. Joints shall be of the bell and spigot type. Sections shall have water-tight joints.

Part 3 Execution

3.01 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 02200 Earthwork.

3.02 Piping Installation

A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Solid pipe shall be butt fusion welded per manufacturer's written instructions. Perforated pipe shall be installed with perforations down.

B. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.

C. Join perforated PE pipe and fittings with couplings according to ASTM D 3212 with loose banded, coupled, or push-on joints.

3.03 Cleaning

Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

-End of Section-

SECTION 03410
Precast Concrete Pipe

SECTION 03410
Precast Concrete Pipe

Part 1 General

1.01 Related Sections

Section 02200 Earthwork

Section 02233 Drain Gravel/Coarse Aggregate

1.02 References

Where applicable, the latest editions of the following standards shall form a part of this specification to the extent referenced. The publications are referenced to in the text of this guide specification by the basic designation only.

American Concrete Pipe Association (ACPA)

ACPA Concrete Pipe Handbook

ACPA Design Manual

ASTM International (ASTM)

ASTM C14 Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe

ASTM C76 Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe

National Precast Concrete Association (NCPA)

NCPA QC Manual Quality Control Manual for Precast Concrete Plants

1.03 General Requirements

Precast concrete units shall be designed and fabricated by an experienced and acceptable precast concrete manufacturer. The manufacturer shall have been regularly and continuously engaged in the manufacture of precast concrete units similar to that indicated in the project specifications or drawings for at least 10 years with annual sales of more than $40 million. In addition, the manufacturer shall employ a professional engineer registered in the state where the product is to be installed.

1.04 Submittals

The following items shall be submitted unless specified otherwise herein.

A. Preconstruction Submittals

1. Upon request by the customer, submit quality control procedures established by the precast manufacturer's Quality Control Manual

B. Drawings

1. The drawings for precast concrete units shall be furnished by the precast concrete producer for approval. These drawings shall show the design loads and standards have been met. Installation and construction information shall be included on shop drawings upon request. Details of steel reinforcing size and placement shall be submitted if a professional engineering stamp and calculations are required by the

customer. It is the responsibility of the project's engineer-of-record to verify that the design assumptions are suitable for the proposed application.

C. Precast Concrete Unit Data

1. Accessory Items

a. For items including, but not limited to sealants, gaskets, pipe entry connectors, steps, racks, and other items installed before or after delivery, the precast concrete producer shall include proper installation instructions and relevant product data upon request.

1.05 Delivery, Storage, and Handling

A. Handling

1. Precast concrete units shall be handled and transported in a manner to minimize damage. Lifting devices or holes shall be consistent with industry standards. Lifting shall be accomplished with methods or devices intended for this purpose as indicated on the shop drawings. Upon request, the precast concrete producer shall provide documentation on acceptable handling methods for the product.

B. Storage

1. Precast concrete units shall be stored in a manner that will minimize potential damage.

C. Delivery

1. Precast concrete units shall be delivered to the site in accordance with the delivery schedule. Upon delivery to the jobsite, all precast concrete units shall be inspected by the customer's agent for quality and final acceptance.

D. Final Acceptance

1. Upon final acceptance, the customer's agent acknowledges and understands the appropriate methods for handling the accepted precast concrete unit(s). Upon acceptance by the customer or customer's agent, the precast concrete manufacturer is not responsible for replacing damaged product resulting from improper handling practices on the job site.

Part 2 Products

2.01 Materials

Except as otherwise specified, material shall conform to the following section.

A. Materials

Cement	Standard Specification for Admixtures to Inhibit ASTM C 150 (Type I, II, III, or V)
	ASTM C 595 (for Blended Cements)
Silica Fume	ASTM C 1240
Fly Ash and Pozzolans	ASTM C 618

Ground Granulated Blast-Furnace Slag	ASTM C 989
Water	ASTM C 1602 (the use of reclaimed/recycled water shall be permitted)
Aggregates	ASTM C 33 (and aggregate specifications)
Air Entraining Admixtures	ASTM C 260
Accelerating, Retarding, Water Reducing Admixtures	ASTM C 494
Corrosion Inhibitors	ASTM C 1582
Reinforcing Bars	ASTM A 615 or ASTM A 706
Plain, Welded Wire Reinforcement	ASTM A 185
Deformed, Welded Wire Reinforcement	ASTM A 497
Epoxy Coated Reinforcing Bars	ASTM A 775
Epoxy Coated Welded Wire Reinforcement	ASTM A 884
Hot-Dipped Galvanizing for Inserts	ASTM A 152
Rubber Gaskets for Circular Pipe	ASTM C 443
External Sealing Bands for Pipe	ASTM C 877
Preformed Flexible Joint Sealants for Concrete Pipe, Manholes, and Manufactured Box Sections	ASTM C 990
Elastomeric Joint Sealants	ASTM C 920
Pipe Entry Connectors	ASTM C 923, ASTM C 1478
Nonshrink Grout	ASTM C 1107

2.02 Manufacture

Manufacture shall conform to the producer's acceptable quality control manual

A. Forms

1. Forms for manufacturing precast concrete units shall be of the type and design consistent with industry standards and practices. They should be capable of consistently providing uniform products and dimensions. Forms shall be constructed so that the forces and vibrations to which the forms will be subjected cause no damage to the precast concrete unit.
2. Forms shall be cleaned of concrete build-up after each use.
3. Form release agents shall be applied according to the manufacturer's recommendations and shall not be allowed to build up on the form casting surface.

B. Reinforcement

1. Cages of reinforcement shall be fabricated by tying the bars, wires or welded wire reinforcement. The tolerances for concrete cover shall be 3/8 in. or as specified in the design. Welding shall be allowed only for ASTM A 706 rebar.

2. Positive means shall be taken to assure that the reinforcement does not move significantly during the casting operations.

C. Concrete

1. Concrete Mixing

   a. Mixing operations shall produce batch-to-batch uniformity of strength, consistency, and appearance.

   b. Batching weight and volume measurement devices shall be annually calibrated by an independent testing laboratory or more frequently if batching irregularities or concrete inconsistencies are observed.

2. Concrete placing

   a. Concrete shall be placed in a manner in which it flows and consolidates without segregation or air entrapment. The freefall of concrete shall be kept to a minimum.

   b. Cold Weather Concreting

      1) Recommendations for cold weather concreting are given in detail in ACI 306 R. Adequate equipment shall be provided for heating concrete materials and protecting concrete during freezing or near-freezing temperatures. All concrete materials, reinforcement, and forms shall be free from frost. In cold weather, the temperature of the concrete at the time of placement shall not be below 45 degrees F. Concrete that freezes before it reaches a compressive strength of 500 psi shall be discarded.

   c. Hot Weather Concreting

      1) Recommendations for hot weather concreting are given in detail in ACI 305 R. During hot weather excessive concrete temperatures and water evaporation shall be minimized. The temperature of concrete at the time of placing shall not exceed 95 degrees F.

3. Concrete Curing

   a. Curing operations shall commence immediately following the initial set of the concrete and completion of surface finishing.

   b. Curing by moisture retention

      1) Precast products shall be protected from drafts and wind to prevent plastic shrinkage cracking.

      2) Moisture shall be prevented from excessively evaporating from exposed surfaces until adequate strength for stripping the precast concrete unit from the form is reached.

c. Curing with Heat and Moisture

1) Concrete shall not be subjected to steam or hot air until after the concrete has attained its initial set. If hot air is used, precautions shall be taken to prevent moisture loss from the concrete. The temperature of the concrete shall not be permitted to exceed 150 degrees F. The temperature gain shall not exceed 40 degrees F per hour.

4. Surface Finish

a. The surface finish shall be as specified on the contract documents and/or approved shop drawings.

5. Stripping Precast Concrete Units from Forms

Precast concrete units shall not be removed from the forms until the concrete reaches the compressive strength for stripping required by design. Stripping strengths shall be routinely measured to ensure product has attained sufficient strength for safe handling.

6. Patching and Repair

a. Repairing Minor Defects

1) Defects that will not impair the functional use or expected life of the precast concrete unit may be repaired by any method that does not impair the product.

b. Repairing Honeycombed Areas

1) When honeycombed areas are to be repaired, all loose material shall be removed and the areas cut back into essentially horizontal or vertical planes to a depth at which coarse aggregate particles break under chipping rather than being dislodged. Proprietary repair materials shall be used in accordance with the manufacturer's instructions. Otherwise, the area shall be saturated with water. Immediately prior to repair, the area should be damp, but free of excess water. A cement-sand grout or an approved bonding agent shall be applied to the chipped surfaces, followed immediately by consolidating an appropriate repair material into the cavity.

c. Repairing Major Defects

1) Defects in precast concrete products which impair the functional use or the expected life of products shall be evaluated by qualified personnel to determine if repairs are feasible and, if so, to establish the repair procedure.

7. Shipping Precast Concrete Units

a. Precast concrete units shall not be shipped until they have reached at least 70% of their specified 28-day design strength, unless damage will not result, impairing the performance of the product.

Part 3 Execution

3.01 Excavating

A. If unforeseen facilities or obstructions are encountered, stop excavation operations immediately. Expose the obstruction with wood handled digging tools and investigate them with caution. If there is any doubt as to the type of obstruction exposed, request positive identification from those suspected of owning the facility and then proceed as circumstances dictate.

B. Inspect excavations after every rainstorm or other hazard-increasing occurrence, and increase the protection against slides and cave-ins, if necessary.

C. In dewatering excavations, make certain that the discharge is carried to a suitable runoff point. Also verify that the design accounts for the level of groundwater encountered.

D. Excavation size shall be large enough to allow access around the structure after it is installed.

3.02 Shoring

A. Shoring for construction shall be in accordance with all federal, state, and local regulations.

3.03 Installation

A. Site Access

1. The general contractor shall be responsible for providing adequate access to the site to facilitate hauling, storage, and proper handling of the precast concrete units.

B. Subgrade Bedding Materials and compaction

1. The installation contractor shall be responsible for ensuring that the subgrade is compacted to 95% of ASTM D698 density. The subgrade shall be a minimum of 6" in depth. A granular material shall be used to create a level surface for placing the precast concrete unit.

C. Installation

1. Precast concrete units shall be installed: to the lines and grades shown on the contract documents or otherwise specified; be lifted by suitable lifting devices at points provided by the precast concrete producer; in accordance with applicable industry standards. Upon request, the precast concrete producer shall provide installation instructions

2. Field modifications to the product shall relieve the precast producer of liability and warranty regardless if such modifications result in the failure of the precast concrete unit.

3.04 Backfilling and Restoration

A. Do the backfilling as soon as possible after the structure has been placed.

B. Backfill material shall be granular and free from large stones, rocks, and pavement. Expansive soil material shall not be used as backfill around the structure.

C. Backfilling shall be achieved by lifts (layers) to the required compaction.

D. Follow up inspections for settlements are required. Should settlement occur, the contractor shall be responsible for all necessary repairs.

3.05 Field Quality Control

A. Job Site Tests

When leak resistance testing is required for a precast concrete structure, one of the following methods may be followed.

1. Vacuum Testing
    a. Prior to backfill, vacuum test system according to ASTM C 1244 for manholes and ASTM C 1227 for septic tanks.
2. Hydrostatic Testing
    a. First Backfill the structure, then fill to the normal water level, let stand for 24 hours. Refill to the original water line and measure the water level change over a 24 hour period. Leak shall not exceed 5% of volume.

B. Inspection

1. Final field elevations and compaction properties shall be verified and documented.

-End of Section-

SECTION 03500
Uniform Section (US) Fabric Formed Concrete Erosion Control Lining System

Section 03500
Uniform Section (US) Fabric Formed Concrete Erosion Control Lining System

Part 1 General

1.01 Scope of Work

Contractor shall furnish all labor, materials, equipment, and incidentals required and perform all operations in connection with the installation of the fabric formed concrete erosion control lining systems in accordance with these specifications, and the Project Construction Quality Assurance (CQA) Plan. The work shall consist of installing an unreinforced concrete lining by positioning specially woven, dual wall synthetic fabric forms on the surface to be protected and filling them with a pumpable fine aggregate concrete (structural grout) in such a manner as to form a stable lining of required thickness and configuration.

1.02 Referenced Documents

A. American Society for Testing and Materials (ASTM)

1. ASTM C 31 Standard Practice for Making and Curing Concrete Test Specimens in the Field
2. ASTM C 33 Standard Specification for Concrete Aggregates
3. ASTM C 39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
4. ASTM C 150 Standard Specification for Portland Cement
5. ASTM C 494 Standard Specification for Chemical Admixtures for Concrete
6. ASTM C 260 Standard Specification for Air-Entraining Admixtures for Concrete
7. ASTM C 618 Standard Specification for Coal Fly Ash and Calcined Natural Pozzolan for Use in Concrete
8. ASTM D 4354 Practice for Sampling of Geotextiles for Testing
9. ASTM D 4491 Standard Test Methods for Water Permeability of Geotextiles by Permittivity
10. ASTM D 4595 Test Method for Tensile Properties of Geotextiles by the Wide Width Strip Method
11. ASTM D 4533 Standard Test Method for Trapezoidal Tearing Strength of Geotextiles
12. ASTM D 4632 Test Method for Breaking Load and Elongation of Geotextiles (Grab Method)
13. ASTM D 4751 Test Method for Determining Apparent Opening Size for a Geotextile
14. ASTM D 4759 Practice for Determining the Specification Conformance of Geotextiles
15. ASTM D 4873 Standard Guide for Identification, Storage, and Handling of Geotextiles

16. ASTM D 4884 Test Method for seam Strength of Sewn Geotextiles
17. ASTM D 5199 Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
18. ASTM D 5261 Test Method for Measuring Mass per Unit Area of Geotextiles
19. ASTM D 6449 Standard Test Method for Flow of Fine Aggregate Concrete for Fabric Formed Concrete (Flow Cone Method)

1.03 Submittal

A. The Contractor shall furnish records of past successful experience in performing this type of work. The Contractor shall also furnish the manufacturer's specifications, literature, shop drawings for the layout of the concrete lining panels, and any recommendations, if applicable, that are specifically related to the project.

B. Alternative fabric formed concrete lining materials may be considered. Such materials must be preapproved in writing by the Owner's Representative prior to the bid date. Alternative material packages must be submitted to the Owner's Representative a minimum of fifteen (15) days prior to the bid date.

Part 2 Products

2.01 General - Fabric Formed Concrete Lining

A. Fabric formed concrete lining(s) shall be Uniform Section (US) type 8" UMNN or approved equal, and have a nominal average thickness of 8 inches.

Table 1.0
CAST-IN-PLACE PROPERTIES OF STYLE 8" UMNN

Physical Properties	Units	Value
Average Thickness (Nominal)	in	8.0
Cord Spacing		3" x 6"
Coverage per Cubic Yard Mortar	ft2	38
Dry Weight	lb/ft2	90

2.02 Fabric Forms

A. The fabric forms for casting the concrete lining(s) shall be as specified, Fabriform® Unimat (as shown on Table 2) fabric forms from Construction Techniques, Inc, 15887 Snow Road, Cleveland, Ohio 44142, Tel: 216.267.7310; or approved equal. The fabric forms shall consist of woven double-layer, open selvage fabric joined in a mat configuration. Fabric shall be woven of 100% high-tenacity, continuous multifilament nylon of which a minimum of 50%, by weight, shall be textured fiber. The fabric shall conform to the properties required on Table 2.0. The fabric forms shall be free of defects or flaws which significantly affect their physical, mechanical, or hydraulic properties.

Table 2.0
PROPERTY REQUIREMENTS – CONCRETE EROSION CONTROL LINING SYSTEM FABRIC

	Test Method	Units	Minimum Values
Physical Properties			
Composition of Yarns			Nylon
Mass Per Unit Area (double-layer)	ASTM D 5261	oz/yd2 (g/m2)	13(440)
Thickness	ASTM D 5199	mils (mm)	30 (0.76)
Mechanical Properties			
Wide-Width Strip Tensile Strength	ASTM D 4595		
Warp		lbf/in (kN/m)	300 (52.5)
Fill		lbf/in (kN/m)	200 (35)
Elongation at Break	ASTM D 4595		
Warp		%	15
Fill		%	20
Grab Tensile Strength	ASTM D 4632		
Warp		lbf (N)	400 (1780)
Fill		lbf (N)	250 (1110)
Grab Tensile Elongation	ASTM D 4632		
Warp		%	30
Fill		%	30
Trapezoidal Tear Strength	ASTM D 4533		
Warp		lbs (N)	175 (775)
Fill		lbs (N)	150 (665)
Hydraulic Properties			
Apparent Opening Size (AOS)	ASTM D 4751	U.S. Standard Sieve (mm)	40 (0.425)
Flow Rate	ASTM D 4491	gal/min/ft2 (l/min/m2)	90 (3665)

B. Fabric forms shall be woven with nylon spacer cords to provide points of attachment on specific centers. The spacer cords shall serve to control the thickness of the revetment without bursting the fabric during the fine aggregate injection.

C. The fabric forms shall be factory sewn, by joining the together top layer to top layer and bottom layer to bottom layer, into predetermined custom sized panels. All factory sewn seam shall be downward facing. Factory sewn seams and zipper attachments shall be made using a double-needled machine utilizing a Standard Type 401 stitch. A single seam in which all four layers of fabric are joined at one point will not be permitted.

D. The Contractor shall submit the fabric form manufacturer's certificate that the supplied fabric forms meet the criteria of these Specifications, as measured in full accordance with the test methods and standards referenced herein. The certificates shall include the following information about each fabric form delivered:

Manufacturer's name and current address;

Full product name;

Style and product code number;

Form number(s);

Composition of yarns; and

Manufacturer's certification statement.

2.03 Fine Aggregate Concrete

A. Fine aggregate concrete shall consist of a proportioned mixture of Portland cement, fine aggregate (sand) and water mixed to provide a readily flowable grout. The mix shall exhibit a compressive strength of 2,500 lb/in^2 (17 MPa) at 28 days, when made and tested in accordance with ASTM C 31 and C 39.

B. At the direction of the Owner's Representative, the Contractor shall demonstrate the suitability of the fine aggregate concrete mix design by pumping the proposed fine aggregate concrete into 5 ½" (140 mm) diameter sleeves. The sleeves shall be constructed of a single layer of the same fabric as the forms. Test cylinders, 12" (300 mm) long, shall be cut from each specimen and tested in accordance with ASTM C 39. The test shall be performed at the start of the project unless directed by the engineer. The average compressive strength of the fabric cast cylinders shall be at least 20 percent higher at 7 days than that of the companion test cylinders made in accordance with ASTM C 31, and not less than 3,000 psi (21 MPa) at 28 days.

C. If required, bulkheads (grout stops) may be installed parallel to and in between individual mill widths at predetermined intervals to regulate the flow of fine aggregate concrete. Grout stops shall be designed as to produce full mat thickness along the full length of the grout stop.

D. Water for mixing shall be clean and free from injurious amounts of oil, acid, salt, alkali, organic matter or other deleterious substances.

E. Admixtures and/or pozzolan may be used with the approval of the Owner's Engineer. Use of superplasticizers requires special precautions. Use of silica fume is not recommended. Pozzolan, if used, shall conform to ASTM C 618, Class C, F, or N.

Part 3 Execution

3.01 Installation

A. The fabric forms shall be stored in a clean, dry area where it will not be subject to mechanical damage or exposure to moisture or direct sunlight. Fabric shall be kept dry prior to installation.

B. Areas on which fabric formed concrete lining are to be installed shall be constructed to the lines, grades, contours, and dimensions shown on the Contract Drawings. The areas shall be free of all obstructions and organic material such as projecting stones and roots. Where required by the Owner's Representative, soft and otherwise unsuitable subgrade soils shall be identified, excavated, and replaced with select materials in accordance with Section 02200 Earthwork. Where such areas are below the allowable grades, they shall be brought to grade by placing compacted layers in accordance with Section 02200 Earthwork.

C. Excavation and preparation of anchor, flank and toe trenches or toe aprons shall be done in accordance with the lines, grades, contours, and dimensions shown on the Contract Drawings.

D. Immediately prior to placing the fabric forms, the prepared area shall be inspected by the Owner's Engineer, and no forms shall be placed thereon until the area has been approved.

3.02 Fabric Form Placement

A. Fabric panels shall be positioned, as specified by the Engineer, at their approximate design location. Adjacent fabric form panels shall be joined in the field by means of sewing or zippering closures. Adjacent panels shall be joined top layers to top layer and bottom layer to bottom. All sewn seams shall be downward facing. When placing panels an allowance for approximately 4 percent contraction of the form in each direction which will occur as a result of fine aggregate concrete filling.

B. When conventional joining of fabric forms is impractical or where called for on the Drawings, adjacent forms may be overlapped a minimum of 3 feet (1 m) to form a lap joint, pending approval by the Owner's Representative. Based on the predominant flow direction, the downstream edge of the form shall overlap the upstream edge of the next form. In no case shall simple butt joints between forms be permitted. However, a modified butt joint where an underlayment of similar fabric is sewn to one panel and overlapped a minimum of 2 feet by the adjacent panel in allowed subject to approval by the Owner's Engineer.

C. Immediately prior to filling with fine aggregate concrete, the assembled fabric forms shall be inspected by the Owner's Representative, and no fine aggregate concrete shall be pumped therein until the fabric placement and field seams have been approved. At no time shall the unfilled fabric forms be exposed to ultraviolet light (including direct sunlight) for a period exceeding 5 days.

3.03 Fine Aggregate Concrete Placement

A. Following the placement of the fabric forms, fine aggregate concrete shall be pumped between the top and bottom layers of the fabric form through small slits be cut in the top layer of the fabric. These slits shall be of the minimum length to allow proper insertion of a filling pipe inserted at the end of the injection pipe. The injection pipe shall be wrapped tightly at the point of injection with a strip of burlap during pumping. First pump the upper edge of the mat which has been placed in the anchor trench followed by injection into the lower edge, working back up the slope. Avoid over-pressuring of the fabric. After pumping, the burlap shall be pushed into the slit as the injection pipe is withdrawn in order to minimize spillage of grout on the revetment surface. The burlap seal shall be removed prior to the final set of the fine aggregate concrete and the injection area hand-finished. The sequence of grout injection shall be such as to ensure complete filling of the revetment forming fabric to the thickness specified by the fabric manufacturer.

B. Fine aggregate concrete shall be pumped in such a manner that cold joints are avoided. A cold joint is defined as one in which the pumping of the fine aggregate concrete into a given form is discontinued or interrupted for an interval of 45 or more minutes.

C. Prior to removing the filling pipe from the current concrete lining section and proceeding to the fine aggregate concrete filling of the adjacent lining section, the thickness of the current lining section shall be measured by inserting a length of stiff wire through the lining at several locations from the crest to the toe of the slope. Any mat measuring less than 90 percent of the average of all thickness measurements shall be re-injected until desired average thickness has been attained.

D. Foot traffic will not be permitted on the freshly pumped concrete lining when such traffic will cause permanent indentations in the lining surface. Walk boards shall be used where necessary.

E. Excessive fine aggregate concrete that has inadvertently spilled on the concrete lining surface shall be removed with a broom and shovel. The use of a water hose to remove spilled fine aggregate concrete from the surface of the freshly pumped concrete lining shall not be permitted.

F. After the fine aggregate concrete has set, all anchor, flank and toe trenches shall be backfilled and compacted, as specified by the Owner's Representative.

-End of Section-